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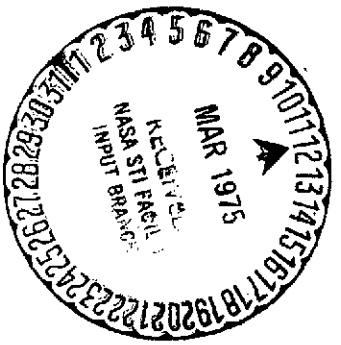
AN AUTOMATED PROGRAM FOR REINFORCEMENT REQUIREMENTS FOR OPENINGS IN CYLINDRICAL PRESSURE VESSELS

By

John F. Wilson and John T. Taylor

January 1975



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16. Abstract

This paper describes an automated "interactive" program for calculating the reinforcement requirements for openings in cylindrical pressure vessels subjected to internal pressure. The equations are from the 1974 edition of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I. The program is written for an electronic desk top calculator. The program calculates the required area of reinforcement for a given opening and compares this value with the area of reinforcement provided by a proposed design.

All program steps, operating instructions, and example problems with input and sample output are documented.

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AN AUTOMATED PROGRAM FOR REINFORCEMENT REQUIREMENTS FOR OPENINGS IN CYLINDRICAL PRESSURE VESSELS

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NASA

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HAMPTON, VIRGINIA

SUMMARY

This paper presents an interactive, automated design solution for reinforcement requirements for openings in pressure vessels using the methods in the 1974 edition of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Paragraph UG 36 - UG 41, pages 28 - 34 and Paragraph UA 280, pages 353 - 361 (reference 1). The design equations used in this program are restricted to cylindrical vessels under internal pressure designed in accordance with Paragraph UG 27.

The program allows for the determination of reinforcement requirements for a given opening. It considers the contribution of metal in the shell and nozzle not needed to restrain pressure, an inner projection of a nozzle, weld metal, and inside and outside reinforcing pads. Only metal inside the limits of reinforcement is considered. It is the responsibility of the designer to insure use of code materials, allowable stresses, design configurations, welding techniques, and special requirements.

The program (approximately 3500 program steps and 41 storage registers) was written for use with a Hewlett-Packard Model 9810A Calculator and 9865A Cassette Memory (reference 2). For users not having Cassette Memory, instructions are provided for using just the calculator.

DESCRIPTION

This program was written, utilizing the design equations of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I, (Paragraphs UG-36 - UG-41 and UA-280), to calculate the area of reinforcement required for an opening in a cylindrical pressure vessel under internal pressure. The area of reinforcement required is compared to the area of reinforcement provided by the proposed configuration. The program considers the following as available reinforcement: metal in the shell and nozzle not needed to restrain pressure, weld metal, an inner projection of a nozzle, and reinforcing pads. Only metal within the limits of reinforcement is considered.

The program is designed to be interactive with the user and it interrogates the user for the required input information. The user has the responsibility to insure that all input information conforms to code requirements. To operate the program, a proposed opening configuration is assumed. The required area of reinforcement is then calculated and compared with that available (assuming no reinforcing pads). If the reinforcement is sufficient, the program is terminated. If more reinforcement is required, the program asks for information on pad configuration(s) and updates metal available for reinforcement. If sufficient reinforcement is not provided by the proposed pad configuration(s), the program will ask for new pad configuration(s). This process will be repeated until the reinforcement requirements are met. The program is terminated when sufficient reinforcement is provided. However, if the area of reinforcement provided is greater than the area required, the user may optimize his design by executing an option to select new reinforcing pad configuration(s).

The program is limited only by conditions imposed by the Code.

To aid the individual in using this program, three items are included. First, a diagram for the program calculation flow including equations and major decision points is shown on pp. 17-24. Second, the computer storage location of the program variables is presentated on p. 16. Third, the complete source documentation for the computer program is listed on pp. 25-44.

AN AUTOMATED PROGRAM FOR REINFORCEMENT REQUIREMENTS FOR OPENINGS IN CYLINDRICAL PRESSURE VESSELS

NOTATION SYMBOLS AND DEFINITIONS

ALL SYMBOLS ARE SHOWN IN THE ORDER THEY APPEAR IN THE PROGRAM

The definitions and figures that are referred to as UG-, UR-, and UW- are those given in the 1974 ASME Boiler and Pressure Vessel Code, Section VIII, Division I (Reference 1).

P = design pressure, pounds per square inch (see UG-21), (or maximum allowable working pressure for existing vessels, see UG-98)

RS = inside radius of the shell course under consideration, before corrosion allowance is added, inches

RN = inside radius of the nozzle course under consideration, before corrosion allowance is added, inches

SS = maximum allowable stress value for the shell material, pounds per square inch (see applicable table of stress values in Subsection C)

SN = maximum allowable stress value for the nozzle material, pounds per square inch (see applicable table of stress values in Subsection C)

ES = joint efficiency for, or the efficiency of, appropriate joint in cylindrical shells and any joint in spherical shells, or the efficiency of ligaments between openings whichever is less:
For welded vessels, use the efficiency specified in UW-12.
For riveted joints, use the efficiency specified in UR-15.
For ligaments between openings, use the efficiency calculated by the rules given in UG-53.

E1 = 1 when an opening is in the plate or when the opening passes through a circumferential joint in a shell or cone (exclusive of head-to-shell joints); or

E1 = the joint efficiency obtained from Table UW-12 when any part of the opening passes through any other welded joint.

TR = minimum required thickness of seamless shell plates, exclusive of corrosion allowance (see UG-25), inches

TRN = minimum required thickness of seamless nozzle plates, exclusive of corrosion allowance (see UG-25), inches

F = a correction factor which compensates for the variation in pressure stresses on different planes with respect to the axis of a vessel. A value of 1.00 shall be used for all configurations except that Fig. UG-37 may be used for integrally reinforced openings in cylindrical shells and cones

RO = the radius in the given plane of the finished opening in its corroded condition, inches

A(REQD) = the total cross-sectional area of reinforcement required in any given plane for a vessel under internal pressure, square inches

T = nominal thickness of the vessel wall, less corrosion allowance, inches

TN = nominal thickness of nozzle wall, less corrosion allowance, inches

A1 = metal in the vessel wall over and above the thickness required to resist pressure and the thickness specified as corrosion allowance, square inches

A2 = metal, in that part of a nozzle wall extending outside the vessel wall, over and above the thickness required to resist pressure and the thickness specified as corrosion allowance, square inches

TL = the limits of reinforcement measured normal to the vessel wall, conforming to the contour of the surface, inches

H = inner nozzle projection, inches

A3 = all metal in the nozzle wall extending inside the vessel wall, square inches

W1 = length of attachment weld leg, see geometry (Fig. 1, p. 7) for location, inches

W2 = length of attachment weld leg, see geometry (Fig. 1, p. 7) for location, inches

A4 = metal in attachment welds (W1 & W2) available for reinforcement, square inches

AS = total metal available for reinforcement for an opening without reinforcement pads, square inches

SP = maximum allowable stress value for pad material, pounds per square inch (see applicable table of stress values in Subsection C)

TE(OUTSIDE) = thickness of attached outside reinforcing pad or height of the largest 60-deg right triangle supported by the vessel and nozzle outside diameter projected surfaces, inches (see Fig. UG-40) (See Operating Hints and Example 3, p. 13)

TE(INSIDE) = thickness of attached inside reinforcing pad or height of the largest 60-deg right triangle supported by the vessel and nozzle outside diameter projected surfaces and lying completely within the area of integral reinforcement, inches (see Fig. UG-40) (see Operating Hints and Example 3, p. 13)

DL = the limits of reinforcement measured parellel to the vessel wall on each side of the axis of the opening, inches

TL(OUTSIDE) = the limits of reinforcement outside the vessel wall and measured normal to the vessel wall conforming to the contour of the surface, inches

TL(INSIDE) = the limits of reinforcement inside the vessel wall and measured normal to the vessel wall conforming to the contour of the surface, inches

A3* = A3 recomputed using new limits, square inches

DP(OUTSIDE)= diameter of outside reinforcing pad, inches

DP(INSIDE) = diameter of inside reinforcing pad, inches

A5(OUTSIDE)= metal in the outside reinforcing pad available for reinforcement, square inches

A5(INSIDE) = metal in the inside reinforcing pad available for reinforcement, square inches

W3 = length of attachment weld leg, see geometry (Fig. 1, p. 7) for location, inches

W4 = length of attachment weld leg, see geometry (Fig. 1, p. 7) for location, inches

A4* = metal in attachment welds (W1+W2+W3+W4) available for reinforcement, square inches

A2* = A2 recomputed considering reinforcing pad, square inches

A(SUM) = total metal available for reinforcement for an opening using reinforcement pads, square inches

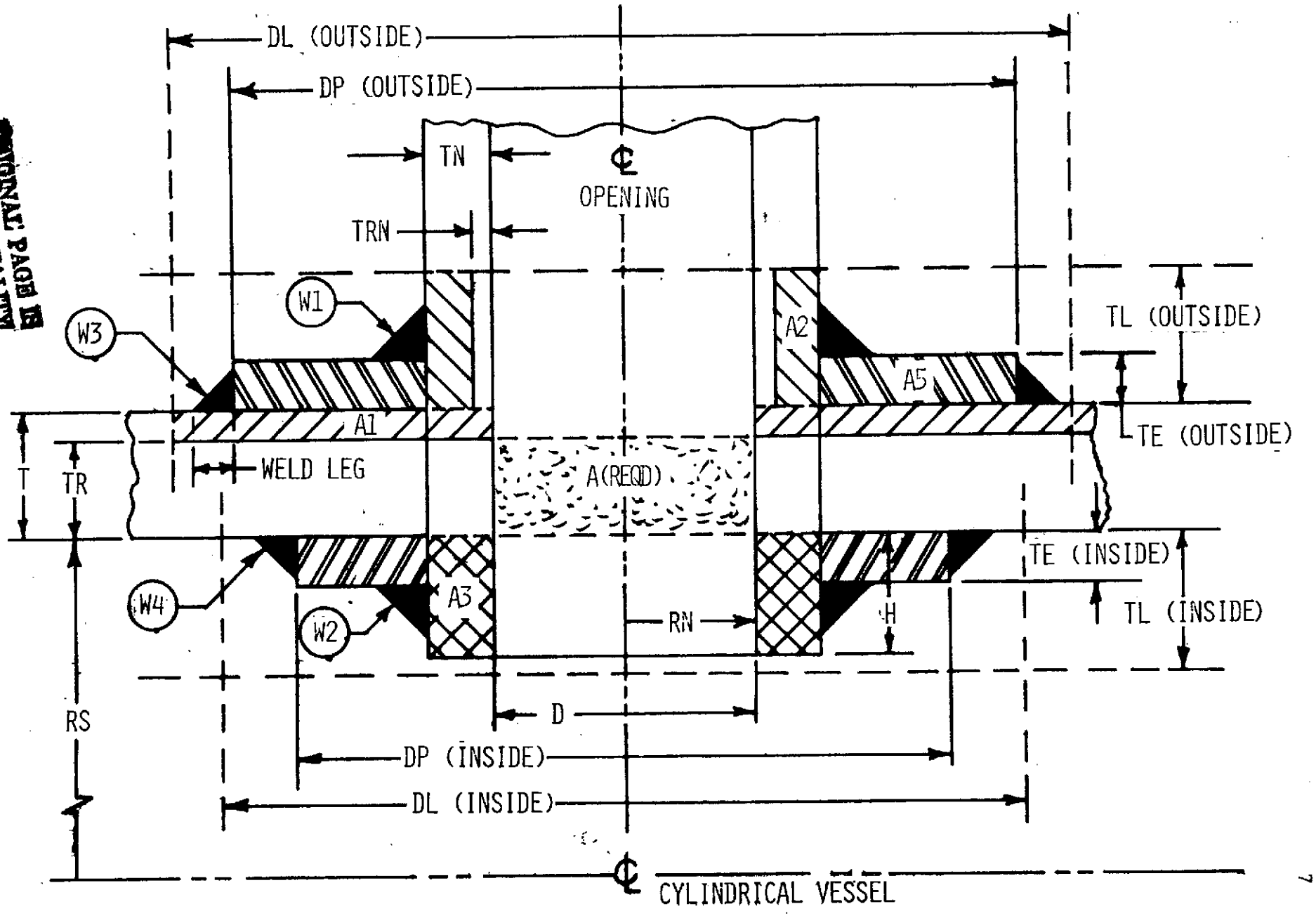
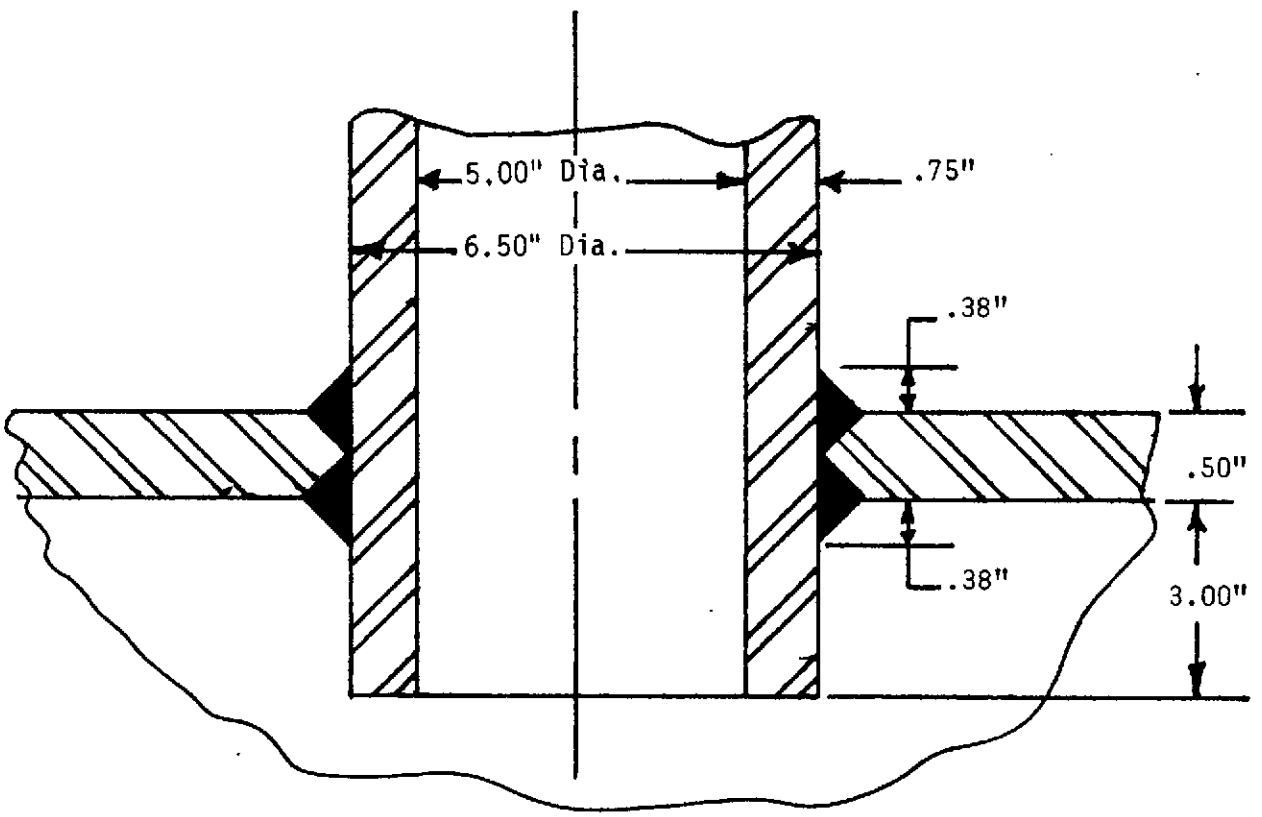


FIG. 1 - GEOMETRY OF REINFORCED OPENING

(See Reference 1 for Allowable Weld Details)

EXAMPLE 1

A 5 in. I.D., 3/4 in. wall, nozzle conforming to Specification SA-181, Grade I, is attached by welding to a vessel that has an inside diameter of 40 in. and a shell thickness of 1/2 in. The nozzle projects into the vessel 3 in. The vessel material conforms to Specification SA-285, Grade C. The vessel is designed for a pressure of 250 lbs. per sq. in. and 150°F. There is no allowance for corrosion. There will be no radiographic examination of welds. The opening passes through a circumferential joint in the shell. Check the opening for reinforcement requirements.

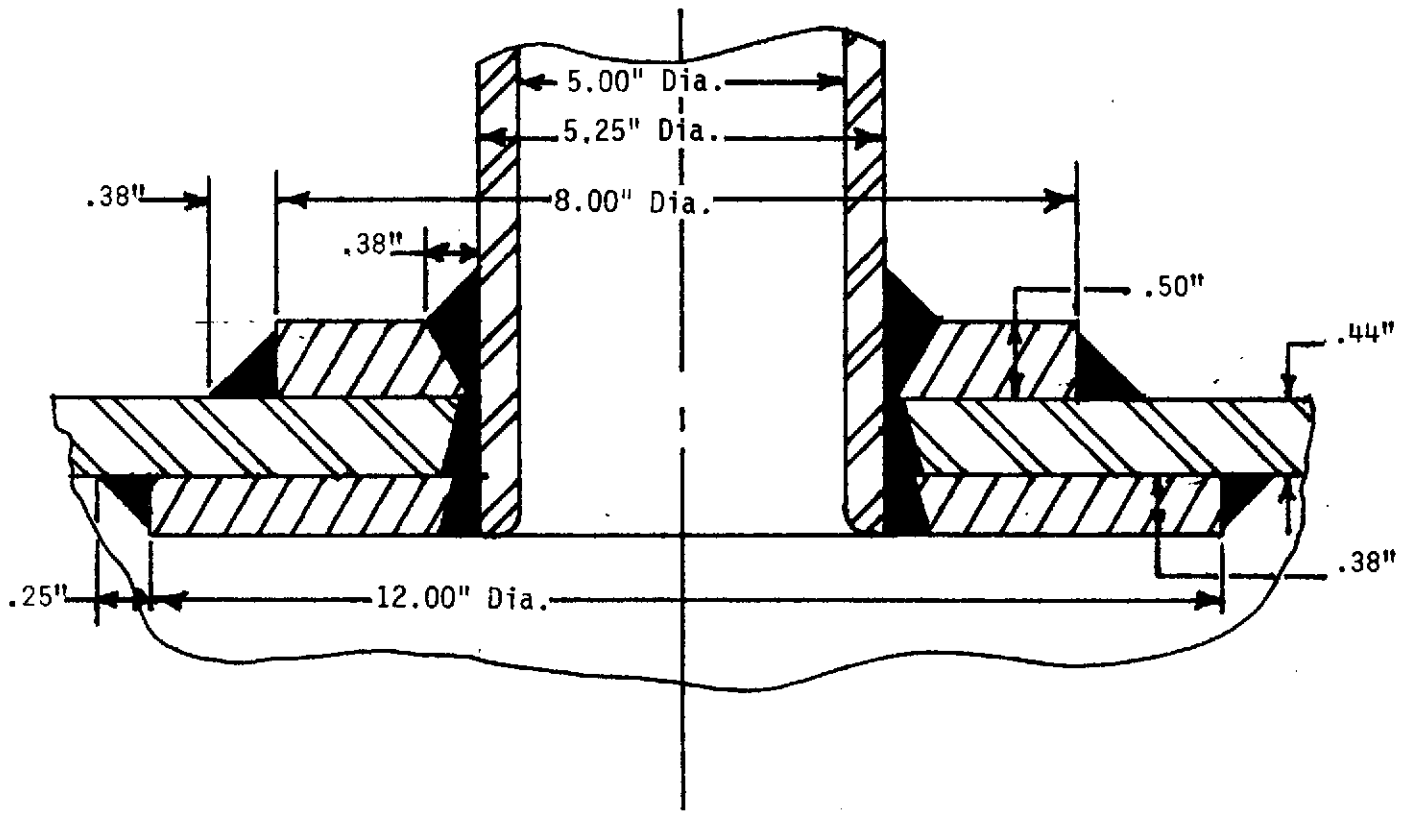


P = 250 lbs. per sq. in.
RS = 20 in.
RN = 2.5 in.
SS = 13,700 lbs. per sq. in.
SN = 15,000 lbs. per sq. in.
ES = 0.70
E1 = 1.0
F = 1.0
RO = 2.5 in.
T = 0.500 in.
TN = 0.75 in.
H = 3.0 in.
W1 = 0.375 in.
W2 = 0.0 in.

```
 REINFORCEMENTS
      FOR
   CYLINDRICAL
 PRESSURE SHELL
  PENETRATIONS
    ASME CODE
SECT. V111 DIV 1


      NOTES
INPUT DIMENSIONS
IN THE CORRODED
CONDITION

PROGRAM LIMITED
TO INTERNAL
PRESSURE


PRESSURE(PSIG)=
        250.0000*
SHELL RAD. (IN)=
         20.0000*
NOZZLE RAD.(IN)=
          2.5000*
ALLOWABLE SHELL
STRESS(PSI)=
      13700.0000*
ALLOWABLE NOZZLE
STRESS(PSI)=
      15000.0000*
JOINT EFFICIENCY
OF SHELL ES=
          0.7000*
JOINT EFFICIENCY
E1.(SEE UG-40)=
          1.0000
REQD SEAMLESS
SHELL THICKNESS=
          0.3690
REQD SEAMLESS
NOZZLE THICK.=
          0.0421
CORRECTION
FACTOR,F
(SEE UG-37) =
          1.0000*
RAD. OF OPENING
IN GIVEN PLANE
IN INCHES=
          2.5000*

REINFORCEMENT
AREA REQUIRED
A(REQD)=
          2.3127

NOMINAL SHELL
WALL(IN)=
          0.5000*
NOMINAL NOZZLE
WALL(IN)=
          0.7500*
SHELL WALL AVAIL
FOR REINFORCMENT
A1=
          0.6550
NOZ. WALL AVAIL
FOR REINFORCMENT
A2=
          1.7698
REINFORCEMENT
LIMITS NORMAL TO
VESSEL WALL
TL=
          1.2500
INNER PROJECTION
H=
          3.0000*
H GREATER TL
SET H=TL=
          1.2500
INNER PROJECTION
 AVAILABLE FOR
 REINFORCEMENT
A3=
          1.8750
LENGTH WELD LEGS

W1=
          0.3750*
W2=
          0.3750*
 WELD AVAILABLE
FOR REINFORCMENT
A4 =
          0.2813



REINFORCED AREA
PROVIDED
AS(A1+A2+A3+A4)=
          4.5810
A(REQD)=
          2.3127
   SUFFICIENT
  REINFORCING
```

EXAMPLE 2

A 5 in. I.D., 1/8 in. wall nozzle conforming to Specifications SA-181, Grade 1, is attached by welding to a vessel that has an inside diameter of 40 in. and a shell thickness of 7/16 in. The shell material conforms to Specification SA-285, Grade C. Spot examination requirements of UW-52 are to be met. The opening passes through a longitudinal seam of the vessel. The opening is to be reinforced on the outside of the vessel with an 8 in. diameter x 1/2 in. thick reinforcing pad and on the inside by a 12 in. diameter x 3/8 in. thick reinforcing pad. The material for both pads conforms to SA-283, Grade A. The vessel is designed for a pressure of 250 lbs. sq. in. and 400°F. There is no allowance for corrosion. Check the opening for reinforcement requirements.



P = 250 lbs. per sq. in.
RS = 20 in.
RN = 2.5 in.
SS = 13,700 lbs. per sq. in.
SN = 15,000 lbs. per sq. in.
ES = 0.85
E1 = 0.85
F = 1.0
RO = 2.5 in.
T = 0.438 in.
TN = 0.125 in.
H = 0.0 in.

W1 = 0.375 in.
W2 = 0.0 in.
SP = 10,300 lbs. per sq. in.
TE(OUTSIDE) = 1/2 in.
TE(INSIDE) = 3/8 in.
DP(OUTSIDE) = 8.0 in.
DP(INSIDE) = 12.0 in.
W1 = 0.375 in.
W2 = 0.0 in.
W3 = 0.375 in.
W4 = 0.250 in.

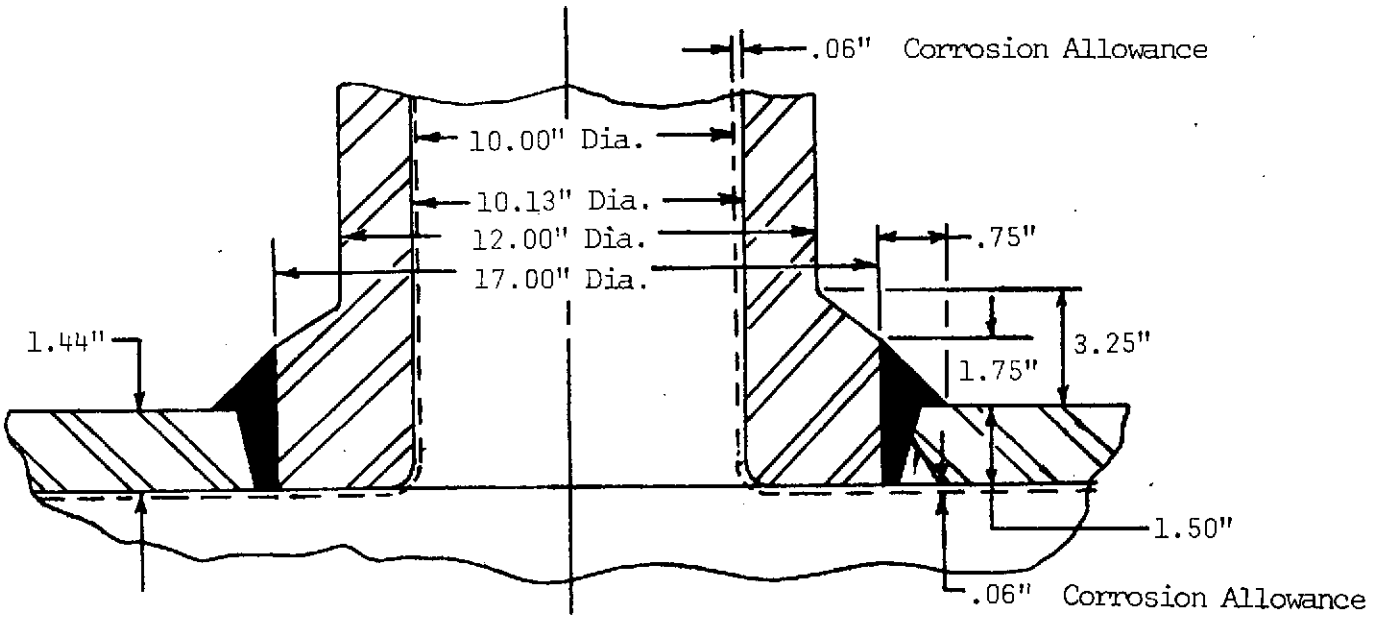
```
 REINFORCEMENTS
      FOR
   CYLINDRICAL
 PRESSURE SHELL
  PENETRATIONS
    ASME CODE
SECT. VIII DIV 1

      NOTES
INPUT DIMENSIONS
IN THE CORRODED
CONDITION

PROGRAM LIMITED
TO INTERNAL
PRESSURE


PRESSURE(PSIG)=
        250.0000*
SHELL RAD. (IN)=
         20.0000*
NOZZLE RAD.(IN)=
          2.5000*
ALLOWABLE SHELL
STRESS(PSI)=
       13700.0000*
ALLOWABLE NOZZLE
STRESS(PSI)=
       15000.0000*
JOINT EFFICIENCY
OF SHELL ES=
          0.8500*
JOINT EFFICIENCY
E1 (SEE UG-40)=
          0.8500
REQD SEAMLESS
SHELL THICKNESS=
         0.3690
REQD SEAMLESS
NOZZLE THICK.=
          0.0421
CORRECTION
FACTOR,F
(SEE UG-37) =
          1.0000*
RAD. OF OPENING
IN GIVEN PLANE
IN INCHES=
          2.5000*

REINFORCEMENT
AREA REQUIRED
A(REQD)=
          1.8450
NOMINAL SHELL
WALL(IN)=
          0.4380*
NOMINAL NOZZLE
WALL(IN)=
          0.1250*
SHELL WALL AVAIL
FOR REINFORCMENT
A1=
          0.0165
NOZ. WALL AVAIL
FOR REINFORCMENT
A2=
          0.0518
REINFORCEMENT
LIMITS NORMAL TO
VESSEL WALL
TL=
          0.3125
INNER PROJECTION
H=
          0.0000*
INNER PROJECTION
 AVAILABLE FOR
 REINFORCEMENT
A3=
          0.0000
LENGTH WELD LEGS

W1=
          0.3750*
W2=
          0.0000*
 WELD AVAILABLE
FOR REINFORCMENT
A4 =
          0.1406



REINFORCED AREA
PROVIDED
AS(A1+A2+A3+A4)=
          0.2089
A(REQD)=
          1.8450
REQD REINFORCED
  AREA GREATER
 THAN AVAILABLE
      AREA

  ADDITIONAL
 REINFORCING
     REQD
```

EXAMPLE 2 PRINTOUT

```
ALLOWABLE PAD
STRESS (PSI)=
     10300.0000*
REINFORCING PAD
THICKNESS
TE(OUTSIDE)=
          0.5000*
TE(INSIDE)=
          0.3750*

REINFORCEMENT
LIMITS

PARALLEL TO
VESSEL WALL
DL=
         10.0000
NORMAL TO VESSEL
WALL
TL(OUTSIDE)=
          0.8125
TL(INSIDE)=
          0.6875

INNER PROJECTION
 AVAILABLE FOR
 REINFORCEMENT
A3*=
          0.0000
DIAMETER OF
REINFORCING PAD
DP(OUTSIDE)=
          8.0000*
DP(INSIDE)=
         12.0000*
DP(INSIDE) GTR
    DL(INSIDE)
SET DP=DL=
         10.0000
A5(OUTSIDE)=
          1.0338
A5(INSIDE)=
          1.3392

WELD LEG LENGTH
W1=
          0.3750*
W2=
          0.0000*
W3=
          0.3750*
W4=
          0.2500*

W4 OUTSIDE LIMIT
OF REINFORCEMENT
(NOT CONSIDERED)

WELD AVAILABLE
FOR REINFORCMENT
A4*=
          0.2813
NOZ. WALL AVAIL
FOR REINFORCMENT
A2*=
          0.1347
A(SUM)=
(A1+A2*+A3*+A4*+
A5(OUT)+A5(IN))=
          2.8054
A(REQD)=
          1.8450
    SUFFICIENT
  REINFORCING



IF REINFORCEMENT
  IS TOO GREAT
  DESIGNER MAY
   OPTIMIZE BY
  VARYING PAD(S)
    PARAMETERS


TO EXERCISE OPTN
  PRESS (CONT)
```

EXAMPLE 3

A 10 in. I.D. weld neck, 1 in. wall, conforming to Specification SA-181, Grade I, is attached by welding to a vessel that has an inside diameter of 50 in. and a shell thickness of 1-1/2 in. The shell material conforms to Specification SA-285, Grade C. The vessel is to be designed for 500 lbs. per sq. in. and 800°F. An allowance of 1/16 in. for corrosion is to be included in the shell and nozzle thickness. Main seams in the vessel are to be radiographed. The opening does not pass through a main seam. Check the opening for reinforcement requirements.



P	= 500 lbs. per sq. in.	H	= 0.0 in.
RS	= 25.062 in.	W1	= 0.75 in.
RN	= 5.062 in.	SP	= 10,800 lbs. per sq. in.
SS	= 10,200 lbs. per sq. in.	TE(OUTSIDE)	= 2.500 in. (see Note 1)
SN	= 10,800 lbs. per sq. in.	TE(INSIDE)	= 0.0 in.
ES	= 1.0	DP(OUTSIDE)	= 17.0 in.
E1	= 1.0	DP(INSIDE)	= 0.0 in.
F	= 1.0	W1	= 0.0 in.
RO	= 5.062 in.	W2	= 0.0 in.
T	= 1.50-.062 = 1.438 in.	W3	= 0.75 in.
TN	= 1.00-.062 = 0.938 in	W4	= 0.0 in.

Note 1

TAN θ = [(17.00-12.00).5]/3.25 = 0.769

θ = 37.57°

Since 37.57°>30° [ref UG-40(d)]

TE = 3.25 in.

This value (TE=3.25) is used in calculating A2. However, the average height of the reinforcing element (TE=(3.25+1.75).5 = 2.500) is used in calculating A5. Since the program uses TE for both calculations, it is suggested that the average value be used. This results in slightly conservative answers for A2.

```
 REINFORCEMENTS
      FOR
   CYLINDRICAL
 PRESSURE SHELL
  PENETRATIONS
   ASME CODE
SECT. VIII DIV 1


      NOTES
INPUT DIMENSIONS
IN THE CORRODED
CONDITION

PROGRAM LIMITED
TO INTERNAL
PRESSURE


PRESSURE(PSIG)=
        500.0000*
SHELL RAD. (IN)=
          25.0620*
NOZZLE RAD.(IN)=
           5.0620*
ALLOWABLE SHELL
STRESS(PSI)=
       10200.0000*
ALLOWABLE NOZZLE
STRESS(PSI)=
       14800.0000*
JOINT EFFICIENCY
OF SHELL ES=
           1.0000*
JOINT EFFICIENCY
E1 (SEE UG-40)=
           1.0000
REQD SEAMLESS
SHELL THICKNESS=
           1.2658
REQD SEAMLESS
NOZZLE THICK.=
           0.2410
CORRECTION
FACTOR,F
(SEE UG-37) =
           1.0000*
RAD. OF OPENING
IN GIVEN PLANE
IN INCHES=
           5.0620*

REINFORCEMENT
AREA REQUIRED
A(REQD)=
          12.8145
NOMINAL SHELL
WALL(IN)=
           1.4380*
NOMINAL NOZZLE
WALL(IN)=
           0.9380*
SHELL WALL AVAIL
FOR REINFORCMENT
A1=
           1.7438
NOZ. WALL AVAIL
FOR REINFORCMENT
A2=
           3.2687
REINFORCEMENT
LIMITS NORMAL TO
VESSEL WALL
TL=
           2.3450
INNER PROJECTION
H=
           0.0000*
INNER PROJECTION
 AVAILABLE FOR
 REINFORCEMENT
A3=
           0.0000
LENGTH WELD LEGS

W1=
           0.7500*
W2=
           0.0000*
 WELD AVAILABLE
FOR REINFORCMENT
A4 =
           0.5625



REINFORCED AREA
PROVIDED
AS(A1+A2+A3+A4)=
           5.5750
A(REQD)=
          12.8145
REQD REINFORCED
  AREA GREATER
 THAN AVAILABLE
      AREA

  ADDITIONAL
 REINFORCING
      REQD
```

EXAMPLE 3 PRINTOUT

```
ALLOWABLE PAD
STRESS (PSI)=
     10800.0000*
REINFORCING PAD
THICKNESS
TE(OUTSIDE)=
          2.5000*
TE(INSIDE)=
          0.0000*

REINFORCEMENT
LIMITS

PARALLEL TO
VESSEL WALL
DL=
         20.2480
NORMAL TO VESSEL
WALL
TL(OUTSIDE)=
          3.5950
TL(INSIDE)=
          2.3450

INNER PROJECTION
 AVAILABLE FOR
 REINFORCEMENT
A3*=
          0.0000
DIAMETER OF
REINFORCING PAD
DP(OUTSIDE)=
         17.0000*
DP(INSIDE)=
          0.0000*
A5(OUTSIDE)=
         12.5000
A5(INSIDE)=
          0.0000
```

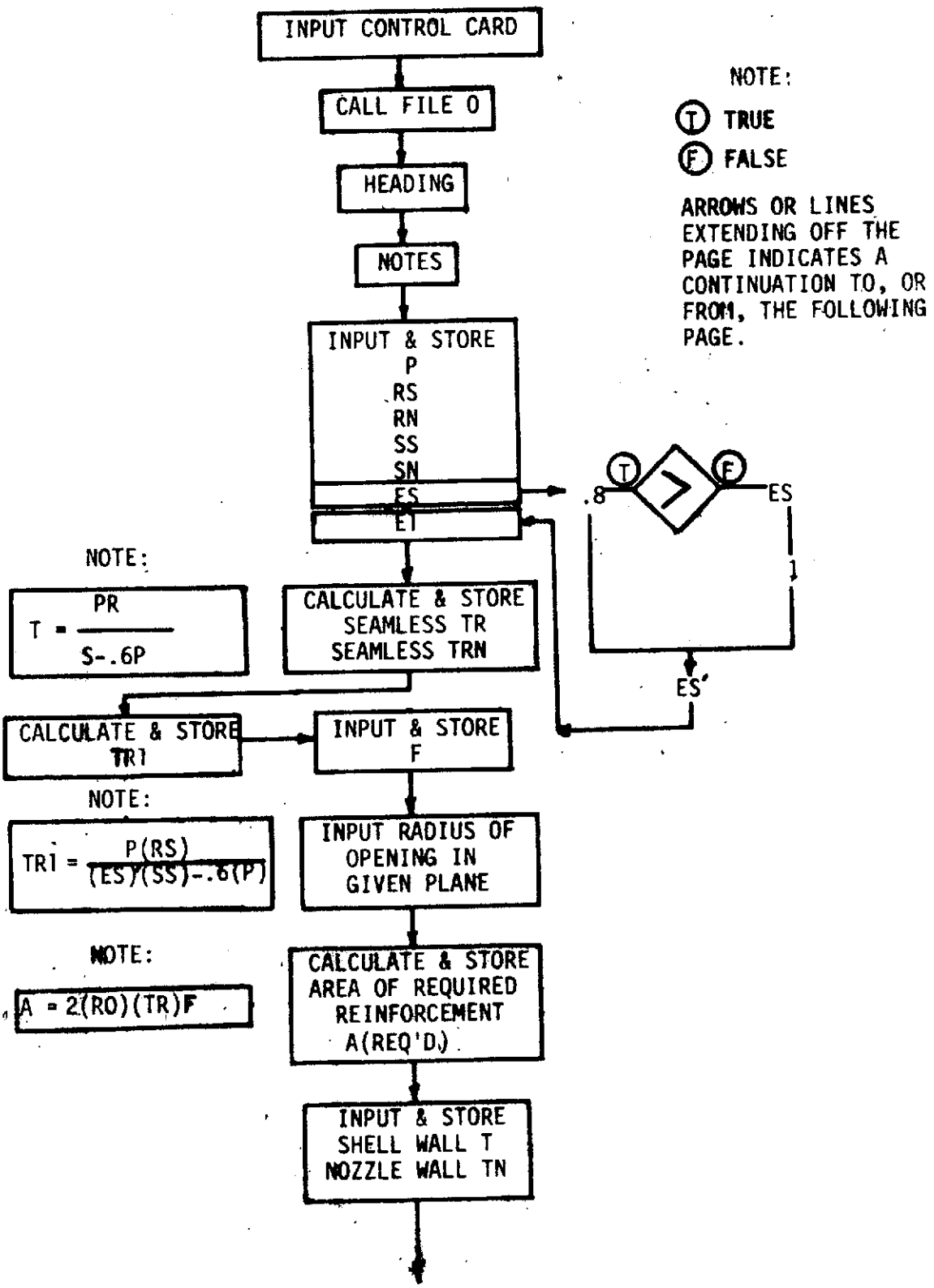
```
WELD LEG LENGTH
W1=
          0.0000*
W2=
          0.0000*
W3=
          0.7500*
W4=
          0.0000*

WELD AVAILABLE
FOR REINFORCMENT
A4*=
          0.5625
NOZ. WALL AVAIL
FOR REINFORCMENT
A2*=
          5.0111
A(SUM)=
(A1+A2*+A3*+A4*+
A5(OUT)+A5(IN))=
         19.8174
A(REQD)=
         12.8145
   SUFFICIENT
  REINFORCING



IF REINFORCEMENT
  IS TOO GREAT
  DESIGNER MAY
   OPTIMIZE BY
  VARYING PAD(S)
    PARAMETERS


TO EXERCISE OPTN
  PRESS (CONT)
```

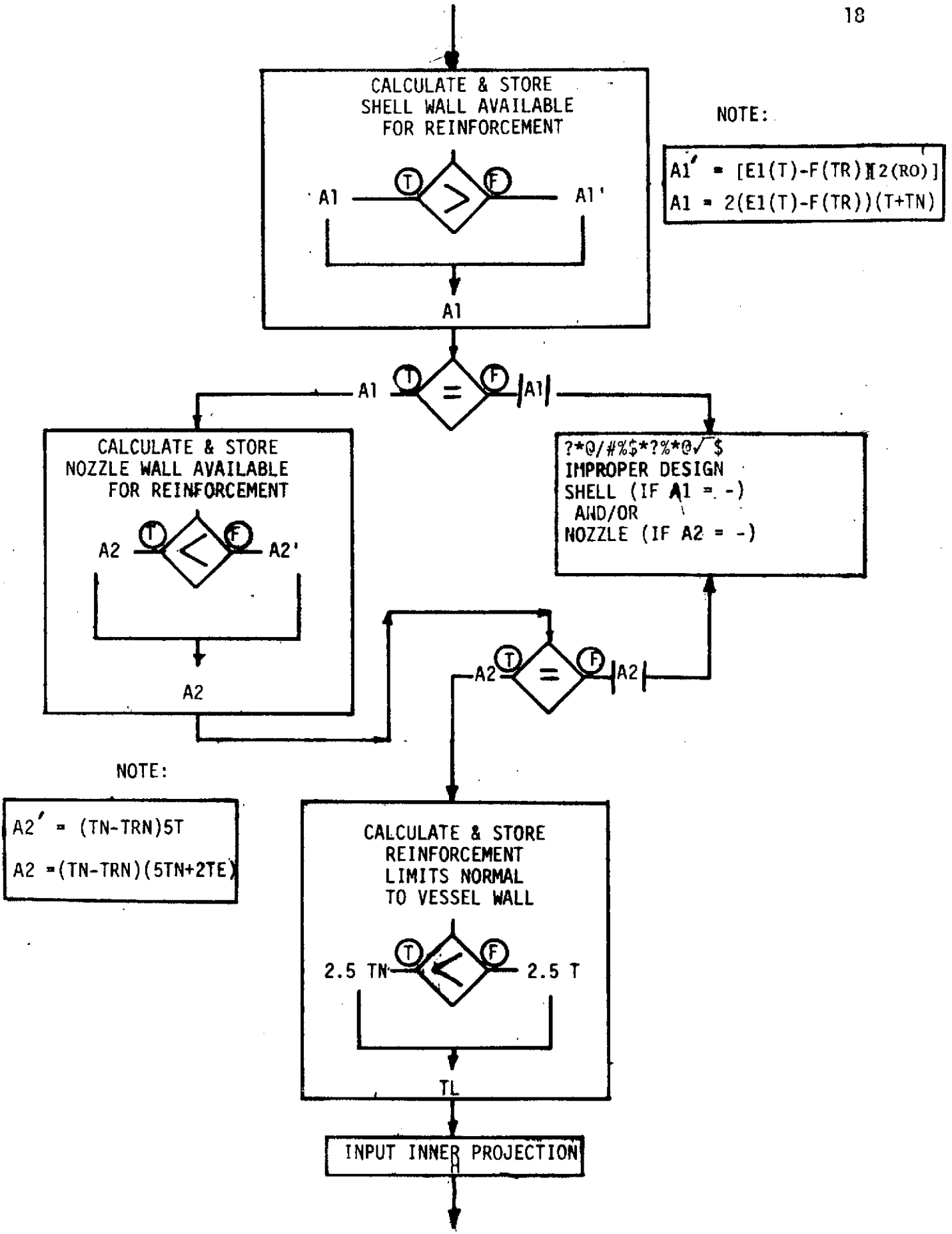
REINFORCEMENT FOR PRESSURE SHELL PENETRATION PROGRAM

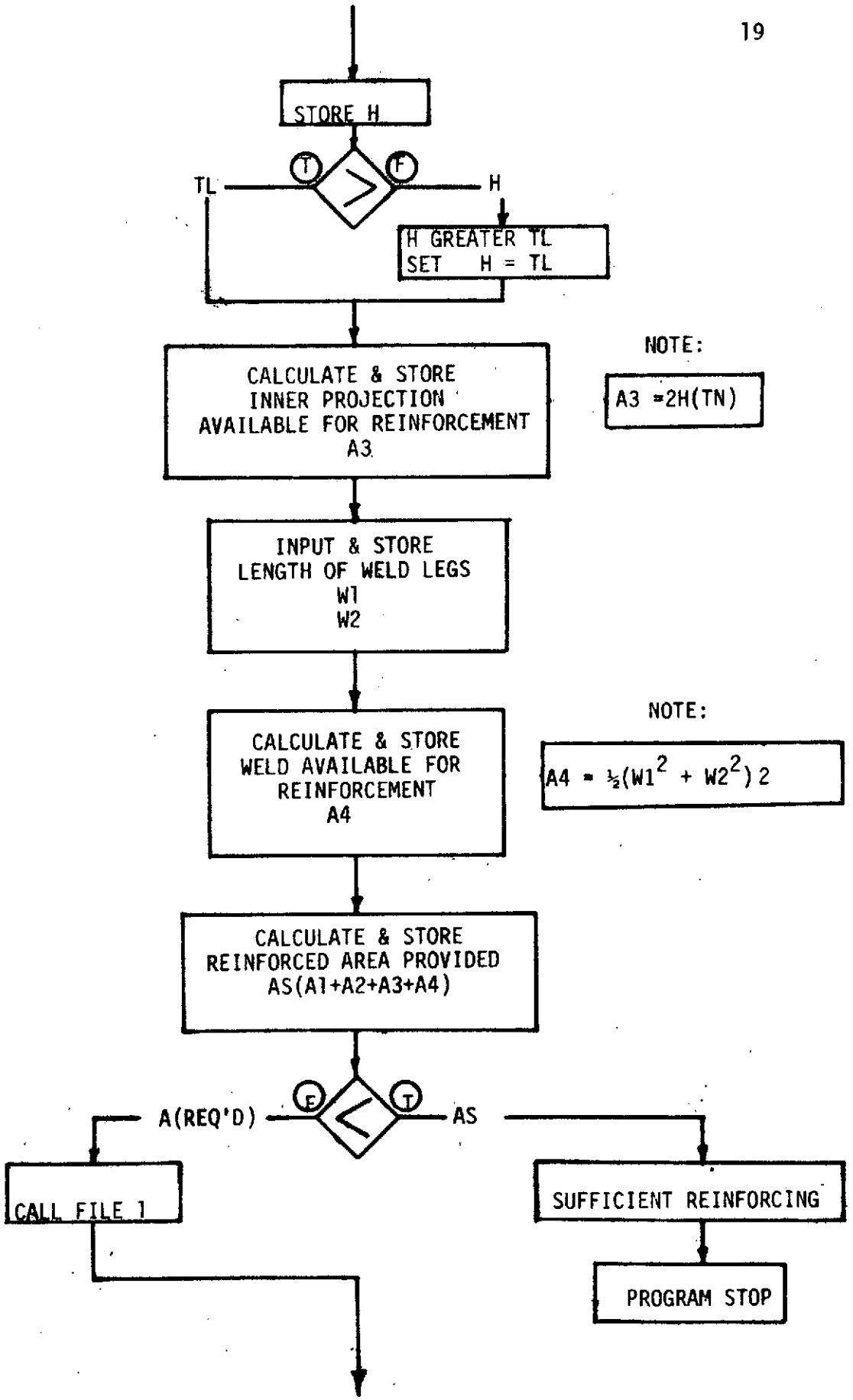
STORAGE LOCATIONS

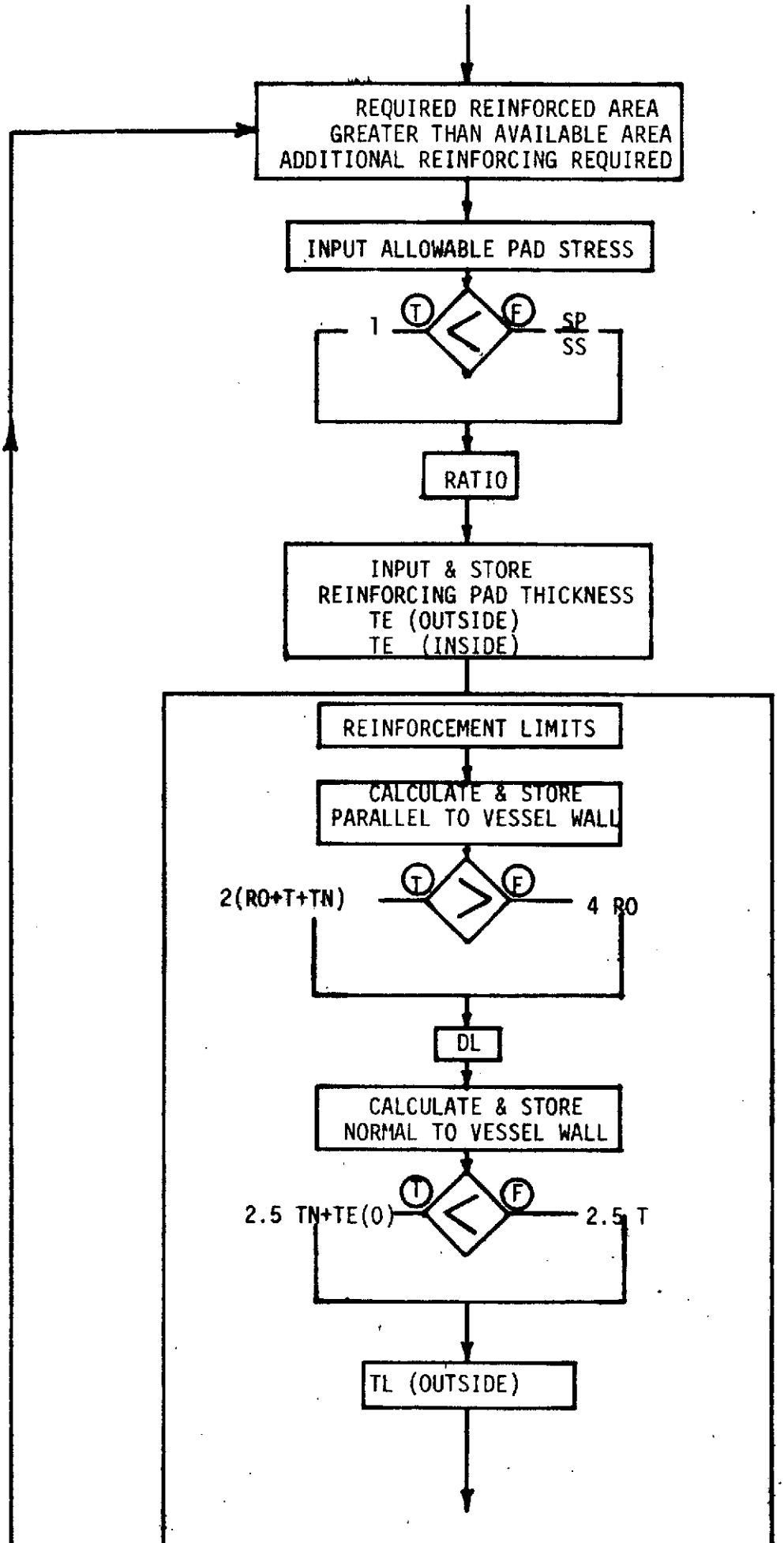
REGISTER	VARIABLE	REGISTER	VARIABLE
a	Not Used	23	W1
b	Not Used	24	W2
00	P	25	W3
01	RS	26	W4
02	RN	27	A4 or A4*
03	SS	28	AS(SUM)
04	SN	29	Not Used
05	ES'	30	TE(INSIDE)
06	TR using ES'	31	Not Used
07	TR1 (E1=1)	32	Not Used
08	TRN (E=1)	33	RATIO
09	D	34	Not Used
10	F	35	TL(INSIDE)
11	A(REQ'D)	36	Not Used
12	T	37	DP(OUTSIDE)
13	TN	38	DP(INSIDE)
14	TE(OUTSIDE)	39	A5(OUTSIDE)
15	DL	40	A5(INSIDE)
16	TL(OUTSIDE)	41	(TN-TRN)(T)(5)
17	E1	42	(TN-TRN)
18	temporary	43	(TN-TRN)(2.5 TN+TE(O))(2)
19	A1	44	(TN-TRN)(2.5 TN+TE(I))(2)
20	A2	45	A2 from comparison
21	H	≥46	Not Used
22	A3 or A3*		

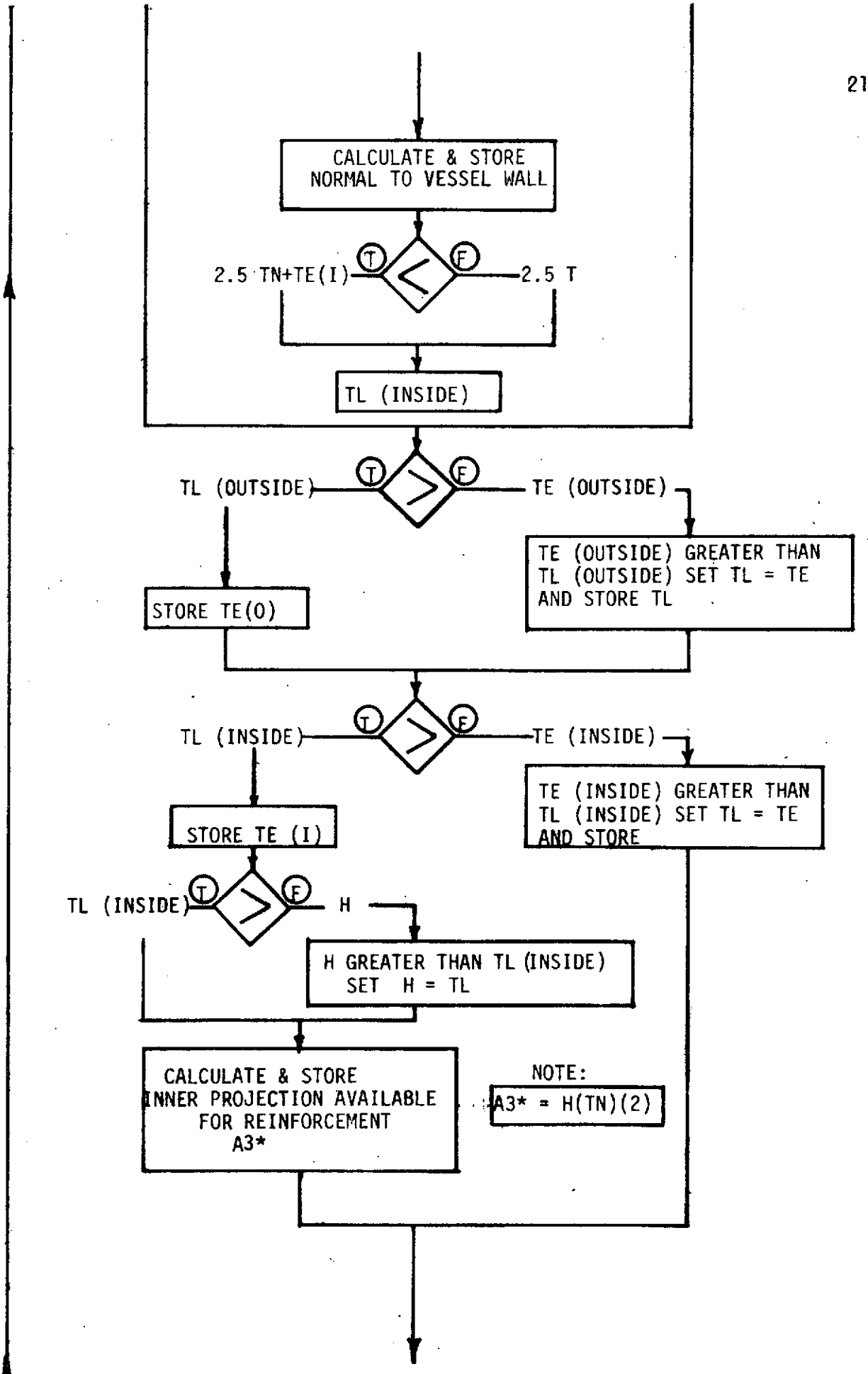
FLOW DIAGRAM
AN AUTOMATED PROGRAM FOR REINFORCEMENT REQUIREMENTS
FOR OPENINGS FOR CYLINDRICAL PRESSURE VESSELS

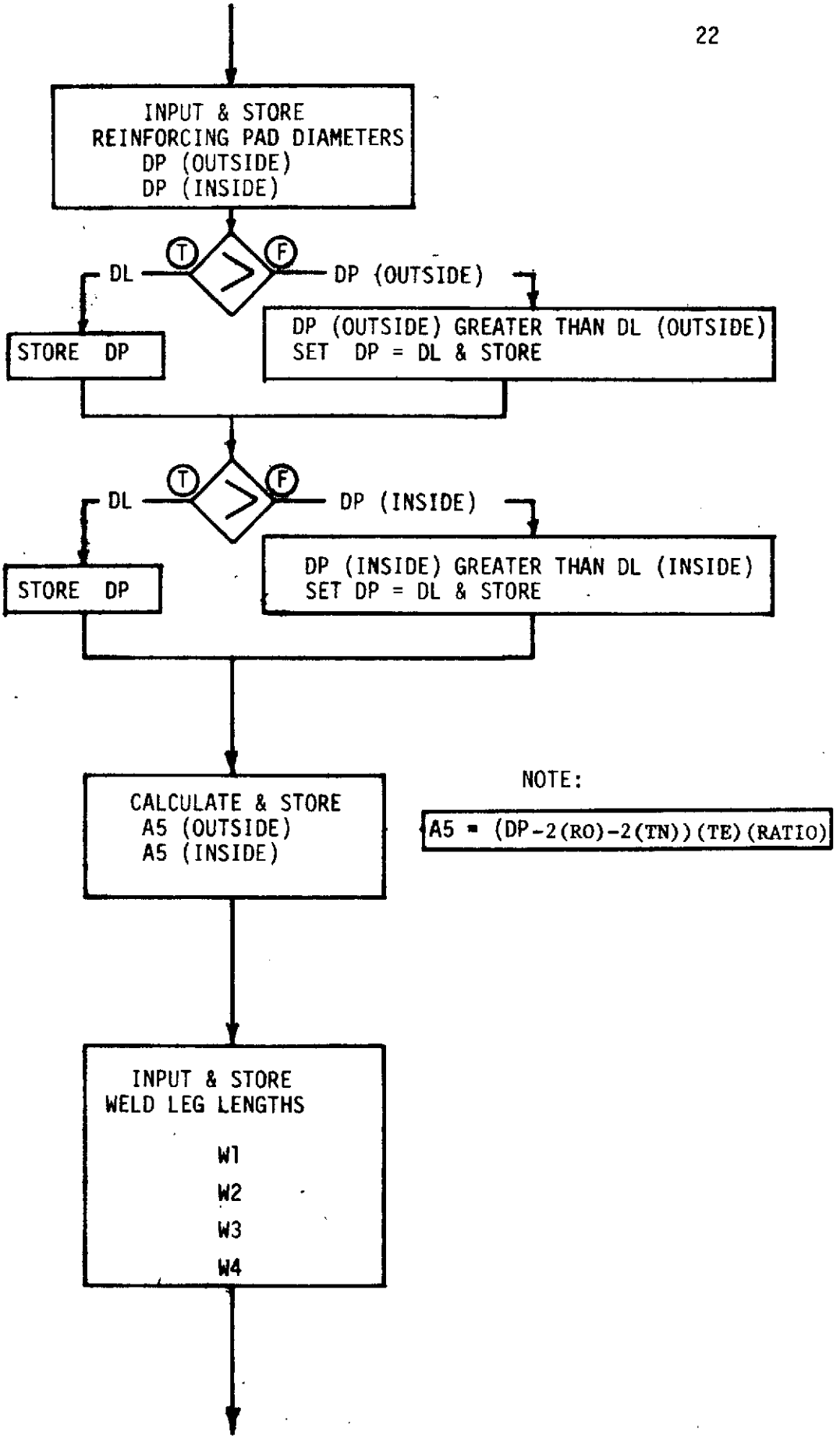


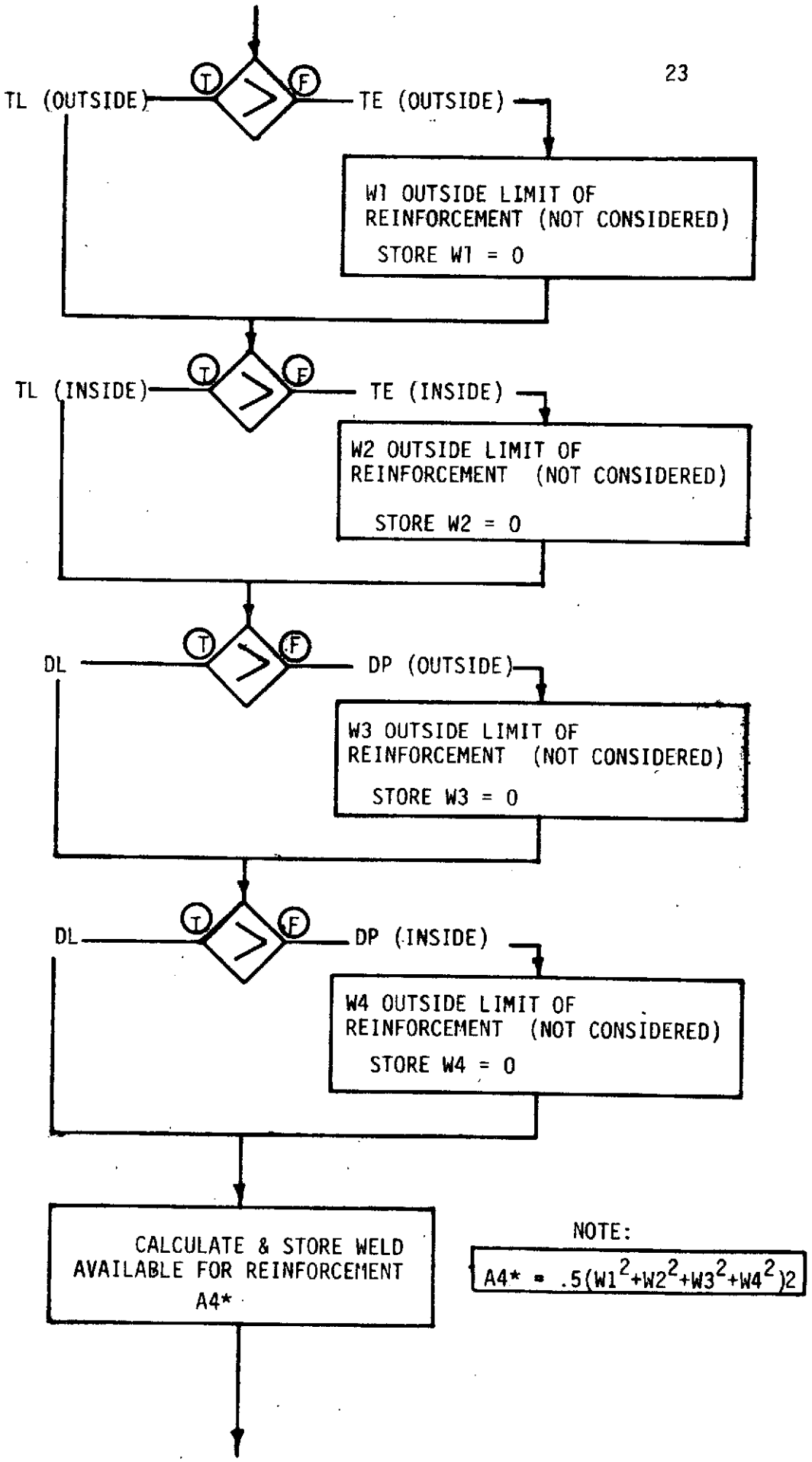

CALCULATE & STORE
SHELL WALL AVAILABLE
FOR REINFORCEMENT
A1
T
F
A1'
A1
NOTE:
A1' = [E1(T)-F(TR)]2(RO)]
A1 = 2(E1(T)-F(TR))(T+TN)
A1
T
=
F
A1
CALCULATE & STORE
NOZZLE WALL AVAILABLE
FOR REINFORCEMENT
A2
T
F
A2'
A2
?*@/#%$*?%*@✓ $
IMPROPER DESIGN
SHELL (IF A1 = -)
AND/OR
NOZZLE (IF A2 = -)
A2
T
=
F
A2
NOTE:
A2' = (TN-TRN)5T
A2 =(TN-TRN)(5TN+2TE)
CALCULATE & STORE
REINFORCEMENT
LIMITS NORMAL
TO VESSEL WALL
2.5 TN
T
F
2.5 T
TL
INPUT INNER PROJECTION

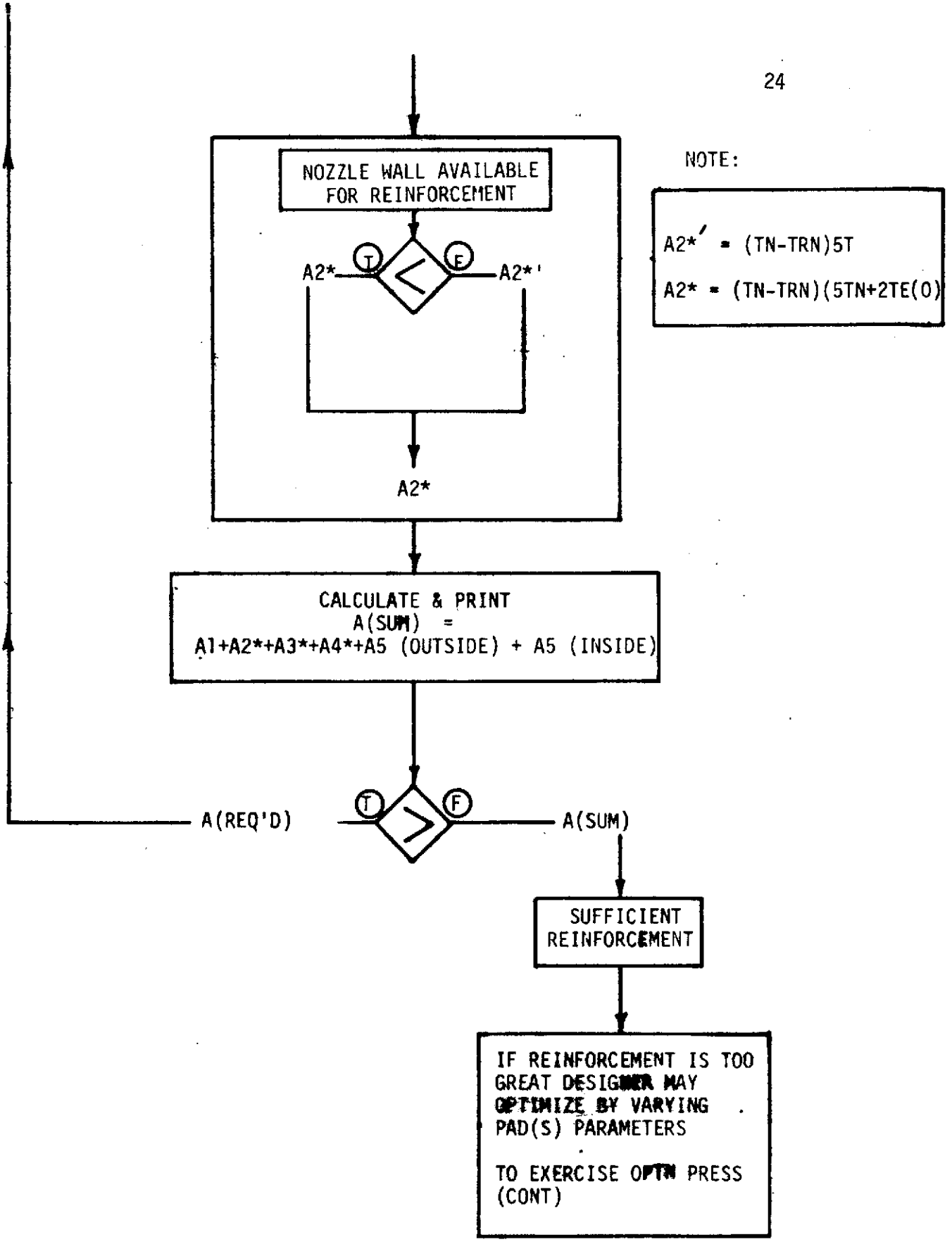

STORE H
T
F
TL
H
H GREATER TL
SET H = TL
CALCULATE & STORE
INNER PROJECTION
AVAILABLE FOR REINFORCEMENT
A3
NOTE:
A3 =2H(TN)
INPUT & STORE
LENGTH OF WELD LEGS
W1
W2
CALCULATE & STORE
WELD AVAILABLE FOR
REINFORCEMENT
A4
NOTE:
A4 = ½(W1² + W2²) 2
CALCULATE & STORE
REINFORCED AREA PROVIDED
AS(A1+A2+A3+A4)
F
T
A(REQ'D)
AS
CALL FILE 1
SUFFICIENT REINFORCING
PROGRAM STOP


REQUIRED REINFORCED AREA
GREATER THAN AVAILABLE AREA
ADDITIONAL REINFORCING REQUIRED
INPUT ALLOWABLE PAD STRESS
T
F
1
SP
SS
RATIO
INPUT & STORE
REINFORCING PAD THICKNESS
TE (OUTSIDE)
TE (INSIDE)
REINFORCEMENT LIMITS
CALCULATE & STORE
PARALLEL TO VESSEL WALL
2(RO+T+TN)
4 RO
DL
CALCULATE & STORE
NORMAL TO VESSEL WALL
2.5 TN+TE(O)
2.5 T
TL (OUTSIDE)


CALCULATE & STORE
NORMAL TO VESSEL WALL
2.5 TN+TE(I)
T
<
F
2.5 T
TL (INSIDE)
TL (OUTSIDE)
T
>
F
TE (OUTSIDE)
STORE TE(O)
TE (OUTSIDE) GREATER THAN
TL (OUTSIDE) SET TL = TE
AND STORE TL
TL (INSIDE)
T
>
F
TE (INSIDE)
STORE TE (I)
TE (INSIDE) GREATER THAN
TL (INSIDE) SET TL = TE
AND STORE
TL (INSIDE)
T
>
F
H
H GREATER THAN TL (INSIDE)
SET H = TL
CALCULATE & STORE
INNER PROJECTION AVAILABLE
FOR REINFORCEMENT
A3*
NOTE:
A3* = H(TN)(2)


INPUT & STORE
REINFORCING PAD DIAMETERS
DP (OUTSIDE)
DP (INSIDE)
T
F
DL
DP (OUTSIDE)
STORE DP
DP (OUTSIDE) GREATER THAN DL (OUTSIDE)
SET DP = DL & STORE
T
F
DL
DP (INSIDE)
STORE DP
DP (INSIDE) GREATER THAN DL (INSIDE)
SET DP = DL & STORE
CALCULATE & STORE
A5 (OUTSIDE)
A5 (INSIDE)
NOTE:
A5 = (DP-2(RO)-2(TN))(TE)(RATIO)
INPUT & STORE
WELD LEG LENGTHS
W1
W2
W3
W4


TL (OUTSIDE)
T
F
TE (OUTSIDE)
W1 OUTSIDE LIMIT OF REINFORCEMENT (NOT CONSIDERED)
STORE W1 = 0
TL (INSIDE)
T
F
TE (INSIDE)
W2 OUTSIDE LIMIT OF REINFORCEMENT (NOT CONSIDERED)
STORE W2 = 0
DL
T
F
DP (OUTSIDE)
W3 OUTSIDE LIMIT OF REINFORCEMENT (NOT CONSIDERED)
STORE W3 = 0
DL
T
F
DP (INSIDE)
W4 OUTSIDE LIMIT OF REINFORCEMENT (NOT CONSIDERED)
STORE W4 = 0
CALCULATE & STORE WELD AVAILABLE FOR REINFORCEMENT
A4*
NOTE:
A4* = .5(W1^2+W2^2+W3^2+W4^2)2


NOZZLE WALL AVAILABLE FOR REINFORCEMENT
A2*
T
F
A2*'
A2*
NOTE:
A2*' = (TN-TRN)5T
A2* = (TN-TRN)(5TN+2TE(0)
CALCULATE & PRINT
A(SUM) =
A1+A2*+A3*+A4*+A5 (OUTSIDE) + A5 (INSIDE)
A(REQ'D)
T
F
A(SUM)
SUFFICIENT REINFORCEMENT
IF REINFORCEMENT IS TOO GREAT DESIGNER MAY OPTIMIZE BY VARYING PAD(S) PARAMETERS
TO EXERCISE OPTN PRESS (CONT)

CONTROL CARD

```
0000--CLR---20
0001--  0 ---00
0002--FMT---42
0003--  5 ---05
0004--CLX---37
0005--  2 ---02
0006--  0 ---00
0007--FMT---42
0008--  5 ---05
0009--S/R---77
0010--GTO---44
0011--  2 ---02
0012--  0 ---00
0013--LBL---51
0014--SFL---54
0015--  2 ---02
0016--  0 ---00
0017--FMT---42
0018--  5 ---05
0019--S/R---77
```

```
0020--FMT---42
0021--FMT---42
0022--PNT---45
0023--  a ---13
0024--  E ---60
0025--  I ---65
0026--  N ---73
0027--  F ---16
0028--  0 ---71
0029--  a ---13
0030--  C ---61
0031--  E ---60
0032--  M ---70
0033--  E ---60
0034--  N ---73
0035--XTO---23
0036--YTO---40
0037--PNT---45
0038--CNT---47
0039--CNT---47
0040--CNT---47
0041--CNT---47
0042--CNT---47
0043--CNT---47
0044--  F ---16
0045--  0 ---71
0046--  a ---13
0047--CLR---20
0048--CNT---47
0049--CNT---47
0050--CNT---47
0051--  C ---61
0052--XFR---67
0053--  L ---72
0054--  I ---65
0055--  N ---73
0056--  D ---63
0057--  a ---13
0058--  I ---65
0059--  C ---61
0060--  A ---62
0061--  L ---72
0062--CLR---20
0063--CNT---47
0064--  π ---56
0065--  a ---13
0066--  E ---60
0067--YTO---40
0068--YTO---40
0069--1/X---17
0070--  a ---13
0071--  E ---60
0072--CNT---47
0073--YTO---40
0074--  H ---74
0075--  E ---60
0076--  L ---72
0077--  L ---72
0078--CNT---47
0079--PNT---45
```

```
0080--PNT---45
0081--  π ---56
0082--  E ---60
0083--  N ---73
0084--  E ---60
0085--XTO---23
0086--  a ---13
0087--  A ---62
0088--XTO---23
0089--  I ---65
0090--  O ---71
0091--  N ---73
0092--YTO---40
0093--PNT---45
0094--PNT---45
0095--PNT---45
0096--PNT---45
0097--PNT---45
0098--  A ---62
0099--YTO---40
0100--  M ---70
0101--  E ---60
0102--PNT---45
0103--  C ---61
0104--  O ---71
0105--  D ---63
0106--  E ---60
0107--CLR---20
0108--YTO---40
0109--  E ---60
0110--  C ---61
0111--XTO---23
0112--  . ---21
0113--PNT---45
0114--INT---64
0115--  1 ---01
0116--  1 ---01
0117--  1 ---01
0118--PNT---45
0119--  D ---63
0120--  I ---65
0121--INT---64
0122--PNT---45
0123--  1 ---01
0124--CLR---20
0125--CLR---20
0126--CNT---47
0127--CNT---47
0128--CNT---47
0129--CNT---47
0130--CNT---47
0131--CNT---47
0132--  N ---73
0133--  O ---71
0134--XTO---23
0135--  E ---60
0136--YTO---40
0137--CNT---47
0138--CLR---20
0139--  I ---65
```

```
0140--  N  ---73
0141--  π  ---56
0142--1/X---17
0143--XTO---23
0144--CNT---47
0145--  D  ---63
0146--  I  ---65
0147--  M  ---70
0148--  E  ---60
0149--  N  ---73
0150--YTO---40
0151--  I  ---65
0152--  O  ---71
0153--  N  ---73
0154--YTO---40
0155--  I  ---65
0156--  N  ---73
0157--CNT---47
0158--XTO---23
0159--  H  ---74
0160--  E  ---60
0161--CNT---47
0162--  C  ---61
0163--  O  ---71
0164--  a  ---13
0165--  a  ---13
0166--  O  ---71
0167--  D  ---63
0168--  E  ---60
0169--  D  ---63
0170--CNT---47
0171--  C  ---61
0172--  O  ---71
0173--  N  ---73
0174--  D  ---63
0175--  I  ---65
0176--XTO---23
0177--  I  ---65
0178--  O  ---71
0179--  N  ---73
0180--CLR---20
0181--CLR---20
0182--  π  ---56
0183--  a  ---13
0184--  O  ---71
0185--  G  ---15
0186--  a  ---13
0187--  A  ---62
0188--  M  ---70
0189--CNT---47
0190--  L  ---72
0191--  I  ---65
0192--  M  ---70
0193--  I  ---65
0194--XTO---23
0195--  E  ---60
0196--  D  ---63
0197--CNT---47
0198--XTO---23
0199--  O  ---71
```

```
0200--CNT---47
0201--  I  ---65
0202--  N  ---73
0203--XTO---23
0204--  E  ---60
0205--  a  ---13
0206--  N  ---73
0207--  A  ---62
0208--  L  ---72
0209--CLR---20
0210--  π  ---56
0211--  a  ---13
0212--  E  ---60
0213--YTO---40
0214--YTO---40
0215--1/X---17
0216--  a  ---13
0217--  E  ---60
0218--CLR---20
0219--CLR---20
0220--CLR---20
0221--  π  ---56
0222--  a  ---13
0223--  E  ---60
0224--YTO---40
0225--YTO---40
0226--1/X---17
0227--  a  ---13
0228--  E  ---60
0229--X<Y---52
0230--  π  ---56
0231--YTO---40
0232--  I  ---65
0233--  G  ---15
0234--PSE---57
0235--SFL---54
0236--FMT---42
0237--STP---41
0238--PNT---45
0239--XTO---23
0240--  0  ---00
0241--  0  ---00
0242--  0  ---00
0243--FMT---42
0244--FMT---42
0245--YTO---40
0246--  H  ---74
0247--  E  ---60
0248--  L  ---72
0249--  L  ---72
0250--CNT---47
0251--  a  ---13
0252--  A  ---62
0253--  D  ---63
0254--  .  ---21
0255--CNT---47
0256--X<Y---52
0257--  I  ---65
0258--  N  ---73
0259--PSE---57
```

```
0260--SFL---54
0261--FMT---42
0262--STP---41
0263--PNT---45
0264--XTO---23
0265--  0  ---00
0266--  0  ---00
0267--  1  ---01
0268--FMT---42
0269--FMT---42
0270--  N  ---73
0271--  O  ---71
0272--XSQ---12
0273--XSQ---12
0274--  L  ---72
0275--  E  ---60
0276--CNT---47
0277--  a  ---13
0278--  A  ---62
0279--  D  ---63
0280--  .  ---21
0281--X<Y---52
0282--  I  ---65
0283--  N  ---73
0284--PSE---57
0285--SFL---54
0286--FMT---42
0287--STP---41
0288--PNT---45
0289--XTO---23
0290--  0  ---00
0291--  0  ---00
0292--  2  ---02
0293--FMT---42
0294--FMT---42
0295--  A  ---62
0296--  L  ---72
0297--  L  ---72
0298--  O  ---71
0299--IND---31
0300--  A  ---62
0301--  B  ---66
0302--  L  ---72
0303--  E  ---60
0304--CNT---47
0305--YTO---40
0306--  H  ---74
0307--  E  ---60
0308--  L  ---72
0309--  L  ---72
0310--CNT---47
0311--YTO---40
0312--XTO---23
0313--  a  ---13
0314--  E  ---60
0315--YTO---40
0316--YTO---40
0317--X<Y---52
0318--  π  ---56
0319--YTO---40
```

```
0320--  I  ---65
0321--PSE---57
0322--SFL---54
0323--FMT---42
0324--STP---41
0325--PNT---45
0326--XTO---23
0327--  0  ---00
0328--  0  ---00
0329--  3  ---03
0330--FMT---42
0331--FMT---42
0332--  A  ---62
0333--  L  ---72
0334--  L  ---72
0335--  O  ---71
0336--IND---31
0337--  A  ---62
0338--  B  ---66
0339--  L  ---72
0340--  E  ---60
0341--CNT---47
0342--  N  ---73
0343--  O  ---71
0344--XSQ---12
0345--XSQ---12
0346--  L  ---72
0347--  E  ---60
0348--YTO---40
0349--XTO---23
0350--  a  ---13
0351--  E  ---60
0352--YTO---40
0353--YTO---40
0354--X<Y---52
0355--  #  ---56
0356--YTO---40
0357--  I  ---65
0358--PSE---57
0359--SFL---54
0360--FMT---42
0361--STP---41
0362--PNT---45
0363--XTO---23
0364--  0  ---00
0365--  0  ---00
0366--  4  ---04
0367--FMT---42
0368--FMT---42
0369--  J  ---75
0370--  O  ---71
0371--  I  ---65
0372--  N  ---73
0373--XTO---23
0374--CNT---47
0375--  E  ---60
0376--  F  ---16
0377--  F  ---16
0378--  I  ---65
0379--  C  ---61
0380--  I  ---65
0381--  E  ---60
0382--  N  ---73
0383--  C  ---61
0384--XFR---67
0385--  O  ---71
0386--  F  ---16
0387--CNT---47
0388--YTO---40
0389--  H  ---74
0390--  E  ---60
0391--  L  ---72
0392--  L  ---72
0393--CNT---47
0394--  E  ---60
0395--YTO---40
0396--SFL---54
0397--FMT---42
0398--STP---41
0399--PNT---45
0400--  UP---27
0401--  .  ---21
0402--  8  ---10
0403--X^Y---53
0404--GTO---44
0405--LBL---51
0406--XSQ---12
0407--CNT---47
0408--  1  ---01
0409--LBL---51
0410--XSQ---12
0411--XTO---23
0412--  0  ---00
0413--  0  ---00
0414--  5  ---05
0415--FMT---42
0416--FMT---42
0417--  J  ---75
0418--  O  ---71
0419--  I  ---65
0420--  N  ---73
0421--XTO---23
0422--CNT---47
0423--  E  ---60
0424--  F  ---16
0425--  F  ---16
0426--  I  ---65
0427--  C  ---61
0428--  I  ---65
0429--  E  ---60
0430--  N  ---73
0431--  C  ---61
0432--XFR---67
0433--  E  ---60
0434--  1  ---01
0435--CNT---47
0436--X<Y---52
0437--YTO---40
0438--  E  ---60
0439--  E  ---60
0440--CNT---47
0441--1/X---17
0442--  G  ---15
0443--  -  ---34
0444--  4  ---04
0445--  0  ---00
0446--PSE---57
0447--SFL---54
0448--CNT---47
0449--FMT---42
0450--STP---41
0451--CNT---47
0452--PNT---45
0453--XTO---23
0454--  0  ---00
0455--  1  ---01
0456--  7  ---07
0457--XFR---67
0458--  0  ---00
0459--  0  ---00
0460--  0  ---00
0461--XFR---67
0462--  X  ---36
0463--  0  ---00
0464--  0  ---00
0465--  1  ---01
0466--  UP---27
0467--XFR---67
0468--  0  ---00
0469--  0  ---00
0470--  3  ---03
0471--CNT---47
0472--CNT---47
0473--CNT---47
0474--CNT---47
0475--CNT---47
0476--  UP---27
0477--  .  ---21
0478--  6  ---06
0479--XFR---67
0480--  X  ---36
0481--  0  ---00
0482--  0  ---00
0483--  0  ---00
0484--  -  ---34
0485--  DN---25
0486--DIV---35
0487--XEY---30
0488--FMT---42
0489--FMT---42
0490--  a  ---13
0491--  E  ---60
0492--  b  ---14
0493--  D  ---63
0494--CNT---47
0495--YTO---40
0496--  E  ---60
0497--  A  ---62
0498--  M  ---70
0499--  L  ---72
```

```
0500--  E  ---60
0501--YTO----40
0502--YTO----40
0503--CNT----47
0504--CNT----47
0505--CNT----47
0506--YTO----40
0507--  H  ---74
0508--  E  ---60
0509--  L  ---72
0510--  L  ---72
0511--CNT----47
0512--XTO----23
0513--  H  ---74
0514--  I  ---65
0515--  C  ---61
0516--  K  ---55
0517--  N  ---73
0518--  E  ---60
0519--YTO----40
0520--YTO----40
0521--SFL----54
0522--FMT----42
0523--PNT----45
0524--XTO----23
0525--  0  ---00
0526--  0  ---00
0527--  7  ---07
0528--XFR----67
0529--  0  ---00
0530--  0  ---00
0531--  3  ---03
0532--XFR----67
0533--  X  ---36
0534--  0  ---00
0535--  0  ---00
0536--  1  ---01
0537--  UP---27
0538--XFR----67
0539--  0  ---00
0540--  0  ---00
0541--  3  ---03
0542--XFR----67
0543--  X  ---36
0544--  0  ---00
0545--  0  ---00
0546--  5  ---05
0547--  UP---27
0548--  .  ---21
0549--  6  ---06
0550--XFR----67
0551--  X  ---36
0552--  0  ---00
0553--  0  ---00
0554--  0  ---00
0555--  -  ---34
0556--  DN---25
0557--DIV----35
0558--XEY----30
0559--XTO----23
0560--  0  ---00
0561--  0  ---00
0562--  6  ---06
0563--XFR----67
0564--  0  ---00
0565--  0  ---00
0566--  0  ---00
0567--XFR----67
0568--  X  ---36
0569--  0  ---00
0570--  0  ---00
0571--  2  ---02
0572--  UP---27
0573--XFR----67
0574--  0  ---00
0575--  0  ---00
0576--  4  ---04
0577--CNT----47
0578--CNT----47
0579--CNT----47
0580--CNT----47
0581--CNT----47
0582--  UP---27
0583--  .  ---21
0584--  6  ---06
0585--XFR----67
0586--  X  ---36
0587--  0  ---00
0588--  0  ---00
0589--  0  ---00
0590--  -  ---34
0591--  DN---25
0592--DIV----35
0593--XEY----30
0594--FMT----42
0595--FMT----42
0596--  a  ---13
0597--  E  ---60
0598--  b  ---14
0599--  D  ---63
0600--CNT----47
0601--YTO----40
0602--  E  ---60
0603--  A  ---62
0604--  M  ---70
0605--  L  ---72
0606--  E  ---60
0607--YTO----40
0608--YTO----40
0609--CNT----47
0610--CNT----47
0611--CNT----47
0612--  N  ---73
0613--  O  ---71
0614--XSQ----12
0615--XSQ----12
0616--  L  ---72
0617--  E  ---60
0618--CNT----47
0619--XTO----23
0620--  H  ---74
0621--  I  ---65
0622--  C  ---61
0623--  K  ---55
0624--  .  ---21
0625--SFL----54
0626--FMT----42
0627--PNT----45
0628--XTO----23
0629--  0  ---00
0630--  0  ---00
0631--  8  ---10
0632--XFR----67
0633--  0  ---00
0634--  0  ---00
0635--  2  ---02
0636--  UP---27
0637--  2  ---02
0638--  X  ---36
0639--YTO----40
0640--  0  ---00
0641--  0  ---00
0642--  9  ---11
0643--FMT----42
0644--FMT----42
0645--  C  ---61
0646--  O  ---71
0647--  a  ---13
0648--  a  ---13
0649--  E  ---60
0650--  C  ---61
0651--XTO----23
0652--  1  ---65
0653--  O  ---71
0654--  M  ---73
0655--CNT----47
0656--CNT----47
0657--CNT----47
0658--CNT----47
0659--CNT----47
0660--CNT----47
0661--  F  ---16
0662--  A  ---62
0663--  C  ---61
0664--XTO----23
0665--  O  ---71
0666--  a  ---13
0667--CLX----37
0668--  F  ---16
0669--CLR----20
0670--X<Y----52
0671--YTO----40
0672--  E  ---60
0673--  E  ---60
0674--CNT----47
0675--1/X----17
0676--  G  ---15
0677--  -  ---34
0678--  3  ---03
0679--  7  ---07
```

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```
0739--  I  --01
0738--  0  --00
0737--  X  --36
0736--XFR--67
0735--PNT--45
0734--STP--41
0733--FMT--42
0732--SFL--54
0731--YTO--40
0730--  E  --60
0729--  H  --74
0728--  C  --61
0727--  N  --73
0726--  I  --65
0725--CNT--47
0724--  N  --73
0723--  I  --65
0722--CLR--20
0721--  E  --60
0720--  N  --73
0719--  H  --62
0718--  L  --72
0717--  4  --56
0716--CNT--47
0715--  N  --73
0714--  E  --60
0713--INT--64
0712--  I  --65
0711--  C  --15
0710--CNT--47
0709--  N  --73
0708--  I  --65
0707--CNT--47
0706--  C  --15
0705--  N  --73
0704--  I  --65
0703--  N  --73
0702--  E  --60
0701--  4  --56
0700--  O  --71
0699--CNT--47
0698--  F  --16
0697--  O  --71
0696--CNT--47
0695--  '  --21
0694--  D  --63
0693--  H  --62
0692--  C  --13
0691--FMT--42
0690--FMT--42
0689--  0  --00
0688--  1  --01
0687--  0  --00
0686--XTO--23
0685--PNT--45
0684--STP--41
0683--FMT--42
0682--SFL--54
0681--CNT--47
0680--PSE--57
```

```
0799--FMT--42
0798--FMT--42
0797--  1  --01
0796--  1  --01
0795--  0  --00
0794--XTO--23
0793--PNT--45
0792--FMT--42
0791--SFL--54
0790--PSE--57
0789--  D  --63
0788--  6  --14
0787--  E  --60
0786--  9  --13
0785--X<Y--52
0784--  H  --62
0783--CNT--47
0782--CNT--47
0781--CNT--47
0780--  D  --63
0779--  9  --13
0778--  E  --60
0777--  I  --65
0776--I/X--17
0775--  9  --14
0774--  E  --60
0773--  9  --13
0772--CNT--47
0771--  H  --62
0770--  E  --60
0769--  9  --13
0768--  H  --62
0767--CNT--47
0766--CNT--47
0765--CNT--47
0764--XTO--23
0763--  N  --73
0762--  E  --60
0761--  M  --70
0760--  E  --60
0759--  C  --61
0758--  9  --13
0757--  O  --71
0756--  F  --16
0755--  N  --73
0754--  I  --65
0753--  E  --60
0752--  9  --13
0751--CLR--20
0750--FMT--42
0749--FMT--42
0748--XEY--30
0747--  X  --36
0746--  2  --02
0745--  UP --27
0744--  6  --06
0743--  0  --00
0742--  X  --36
0741--XFR--67
0740--  0  --00
```

```
0800--CLR--20
0801--  N  --73
0802--  O  --71
0803--  M  --70
0804--  I  --65
0805--  N  --73
0806--  H  --62
0807--  L  --72
0808--CNT--47
0809--YTO--40
0810--  H  --74
0811--  E  --60
0812--  L  --72
0813--  L  --72
0814--CNT--47
0815--CNT--47
0816--CNT--47
0817--IND--31
0818--  H  --62
0819--  L  --72
0820--  L  --72
0821--X<Y--52
0822--  I  --65
0823--  N  --73
0824--PSE--57
0825--SFL--54
0826--FMT--42
0827--STP--41
0828--PNT--45
0829--XTO--23
0830--  0  --00
0831--  1  --01
0832--  2  --02
0833--FMT--42
0834--FMT--42
0835--  N  --73
0836--  O  --71
0837--  M  --70
0838--  I  --65
0839--  N  --73
0840--  H  --62
0841--  L  --72
0842--CNT--47
0843--  N  --73
0844--  O  --71
0845--X<Y--52
0846--XSO--12
0847--  L  --72
0848--  E  --60
0849--CNT--47
0850--CNT--47
0851--IND--31
0852--  H  --62
0853--  L  --72
0854--  L  --72
0855--X<Y--52
0856--  I  --65
0857--  N  --73
0858--PSE--57
0859--SFL--54
```

```
0860--FMT---42
0861--STP---41
0862--PNT---45
0863--XTO---23
0864--  0  ---00
0865--  1  ---01
0866--  3  ---03
0867--  9  ---09
0868--XTO---23
0869--  0  ---00
0870--  1  ---01
0871--  4  ---04
0872--  0  ---00
0873--XTO---23
0874--  0  ---00
0875--  3  ---03
0876--  0  ---00
0877--FMT---42
0878--FMT---42
0879--YTO---40
0880--  H  ---74
0881--  E  ---60
0882--  L  ---72
0883--  L  ---72
0884--PNT---45
0885--IND---31
0886--  R  ---62
0887--  L  ---72
0888--  L  ---72
0889--PNT---45
0890--  R  ---62
0891--INT---64
0892--  A  ---62
0893--  I  ---65
0894--  L  ---72
0895--  F  ---16
0896--  O  ---71
0897--  α  ---13
0898--PNT---45
0899--  α  ---13
0900--  E  ---60
0901--  I  ---65
0902--  N  ---73
0903--  F  ---16
0904--  O  ---71
0905--  α  ---13
0906--  C  ---61
0907--  M  ---70
0908--  E  ---60
0909--  N  ---78
0910--XTO---23
0911--FMT---42
0912--XFR---67
0913--  0  ---00
0914--  1  ---01
0915--  7  ---07
0916--XFR---67
0917--  X  ---36
0918--  0  ---00
0919--  1  ---01
0920--  2  ---02
0921--UP---27
0922--XFR---67
0923--  0  ---00
0924--  1  ---01
0925--  0  ---00
0926--XFR---67
0927--  X  ---36
0928--  0  ---00
0929--  0  ---00
0930--  7  ---07
0931--  -  ---34
0932--XEY---30
0933--XTO---23
0934--  0  ---00
0935--  1  ---01
0936--  8  ---10
0937--UP---27
0938--XFR---67
0939--  0  ---00
0940--  0  ---00
0941--  9  ---11
0942--  X  ---36
0943--XFR---67
0944--  0  ---00
0945--  1  ---01
0946--  8  ---10
0947--UP---27
0948--  2  ---02
0949--  X  ---36
0950--XFR---67
0951--  0  ---00
0952--  1  ---01
0953--  2  ---02
0954--XFR---67
0955--  +  ---33
0956--  0  ---00
0957--  1  ---01
0958--  3  ---03
0959--  X  ---36
0960--DN---25
0961--X>Y---53
0962--GTO---44
0963--LBL---51
0964--  A  ---62
0965--CNT---47
0966--XEY---30
0967--LBL---51
0968--  A  ---62
0969--FMT---42
0970--FMT---42
0971--  A  ---62
0972--  1  ---01
0973--SFL---54
0974--FMT---42
0975--PNT---45
0976--XTO---23
0977--  0  ---00
0978--  1  ---01
0979--  9  ---11
0980--UP---27
0981--  G  ---15
0982--X=Y---50
0983--GTO---44
0984--LBL---51
0985--  Γ  ---76
0986--CNT---47
0987--LBL---51
0988--GTO---44
0989--FMT---42
0990--FMT---42
0991--CLR---20
0992--IFG---43
0993--  X  ---36
0994--RUP---22
0995--DIV---35
0996--GTO---44
0997--X=Y---50
0998--LBL---51
0999--  X  ---36
1000--IFG---43
1001--X=Y---50
1002--  X  ---36
1003--RUP---22
1004--  Γ  ---76
1005--LBL---51
1006--CLR---20
1007--  I  ---65
1008--  M  ---70
1009--  π  ---56
1010--  α  ---13
1011--  O  ---71
1012--  π  ---56
1013--  E  ---60
1014--  α  ---13
1015--CNT---47
1016--  D  ---63
1017--  E  ---60
1018--YTO---40
1019--  I  ---65
1020--  G  ---15
1021--  N  ---73
1022--CNT---47
1023--YTO---40
1024--  H  ---74
1025--  E  ---60
1026--  L  ---72
1027--  L  ---72
1028--CNT---47
1029--X<Y---52
1030--  I  ---65
1031--  F  ---16
1032--CNT---47
1033--  A  ---62
1034--  1  ---01
1035--SFL---54
1036--  -  ---34
1037--PSE---57
1038--CNT---47
1039--CNT---47
```

```
1040--CNT----47
1041--CNT----47
1042--CNT----47
1043--CNT----47
1044--  A  ---62
1045--  N  ---73
1046--  D  ---63
1047--DIV----35
1048--  0  ---71
1049--  a  ---13
1050--CLR----20
1051--  N  ---73
1052--  0  ---71
1053--XSQ----12
1054--XSQ----12
1055--  L  ---72
1056--  E  ---60
1057--CNT----47
1058--X<Y----52
1059--  I  ---65
1060--  F  ---16
1061--CNT----47
1062--  A  ---62
1063--  2  ---02
1064--SFL----54
1065--  -  ---34
1066--PSE----57
1067--FMT----42
1068--STP----41
1069--CNT----47
1070--CNT----47
1071--CNT----47
1072--CNT----47
1073--CNT----47
1074--CNT----47
1075--CNT----47
1076--CNT----47
1077--CNT----47
1078--CNT----47
1079--LBL----51
1080--  J  ---76
1081--FMT----42
1082--FMT----42
1083--  N  ---73
1084--  0  ---71
1085--XSQ----12
1086--  .  ---21
1087--PNT----45
1088--IND----31
1089--  A  ---62
1090--  L  ---72
1091--  L  ---72
1092--PNT----45
1093--  A  ---62
1094--INT----64
1095--  A  ---62
1096--  I  ---65
1097--  L  ---72
1098--PNT----45
1099--  F  ---16
```

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```
1100--  O  ---71
1101--  a  ---13
1102--PNT----45
1103--  a  ---13
1104--  E  ---60
1105--  I  ---65
1106--  N  ---73
1107--  F  ---16
1108--  O  ---71
1109--  a  ---13
1110--  C  ---61
1111--  M  ---70
1112--  E  ---60
1113--  N  ---73
1114--XTO----23
1115--FMT----42
1116--XFR----67
1117--  0  ---00
1118--  1  ---01
1119--  3  ---03
1120--XFR----67
1121--  -  ---34
1122--  0  ---00
1123--  0  ---00
1124--  8  ---10
1125--XTO----23
1126--  0  ---00
1127--  1  ---01
1128--  8  ---10
1129--  UP---27
1130--  5  ---05
1131--  X  ---36
1132--XFR----67
1133--  0  ---00
1134--  1  ---01
1135--  2  ---02
1136--  X  ---36
1137--  5  ---05
1138--XFR----67
1139--  X  ---36
1140--  0  ---00
1141--  1  ---01
1142--  3  ---03
1143--  UP---27
1144--  2  ---02
1145--XFR----67
1146--  X  ---36
1147--  0  ---00
1148--  1  ---01
1149--  4  ---04
1150--  +  ---33
1151--XFR----67
1152--  0  ---00
1153--  1  ---01
1154--  8  ---10
1155--  X  ---36
1156--  DN---25
1157--X<Y----52
1158--GTO----44
1159--LBL----51
```

```
1160--  B  ---66
1161--CNT----47
1162--XEY----30
1163--LBL----51
1164--  B  ---66
1165--FMT----42
1166--FMT----42
1167--  A  ---62
1168--  2  ---02
1169--SFL----54
1170--FMT----42
1171--PNT----45
1172--XTO----23
1173--  0  ---00
1174--  2  ---02
1175--  0  ---00
1176--  UP---27
1177--  G  ---15
1178--X=Y----50
1179--GTO----44
1180--LBL----51
1181--X=Y----50
1182--CNT----47
1183--GTO----44
1184--LBL----51
1185--GTO----44
1186--CNT----47
1187--CNT----47
1188--LBL----51
1189--X=Y----50
1190--XFR----67
1191--  0  ---00
1192--  1  ---01
1193--  2  ---02
1194--  UP---27
1195--  2  ---02
1196--  .  ---21
1197--  5  ---05
1198--  X  ---36
1199--  UP---27
1200--XFR----67
1201--  0  ---00
1202--  1  ---01
1203--  3  ---03
1204--  X  ---36
1205--  DN---25
1206--X<Y----52
1207--GTO----44
1208--LBL----51
1209--  C  ---61
1210--CNT----47
1211--XEY----30
1212--LBL----51
1213--  C  ---61
1214--FMT----42
1215--FMT----42
1216--  a  ---13
1217--  E  ---60
1218--  I  ---65
1219--  N  ---73
```

```
1220--  F  ---16
1221--  O  ---71
1222--  a  ---13
1223--  C  ---61
1224--  E  ---60
1225--  M  ---70
1226--  E  ---60
1227--  M  ---73
1228--XTO----23
1229--CNT----47
1230--CNT----47
1231--CNT----47
1232--  L  ---72
1233--  I  ---65
1234--  M  ---70
1235--  I  ---65
1236--XTO----23
1237--YTO----40
1238--CNT----47
1239--  N  ---73
1240--  O  ---71
1241--  a  ---13
1242--  M  ---70
1243--  A  ---62
1244--  L  ---72
1245--CNT----47
1246--XTO----23
1247--  O  ---71
1248--INT----64
1249--  E  ---60
1250--YTO----40
1251--YTO----40
1252--  E  ---60
1253--  L  ---72
1254--CNT----47
1255--IND----31
1256--  A  ---62
1257--  L  ---72
1258--  L  ---72
1259--CLR----20
1260--XTO----23
1261--  L  ---72
1262--SFL----54
1263--FMT----42
1264--PNT----45
1265--XTO----23
1266--  0  ---00
1267--  3  ---03
1268--  5  ---05
1269--FMT----42
1270--FMT----42
1271--  I  ---65
1272--  N  ---73
1273--  N  ---73
1274--  E  ---60
1275--  a  ---13
1276--CNT----47
1277--  π  ---56
1278--  a  ---13
1279--  O  ---71
1280--  J  ---75
1281--  E  ---60
1282--  C  ---61
1283--XTO----23
1284--  I  ---65
1285--  O  ---71
1286--  N  ---73
1287--  H  ---74
1288--SFL----54
1289--FMT----42
1290--STP----41
1291--PNT----45
1292--XTO----23
1293--  0  ---00
1294--  2  ---02
1295--  1  ---01
1296--  UP---27
1297--XFR----67
1298--  0  ---00
1299--  3  ---03
1300--  5  ---05
1301--X>Y----53
1302--GTO----44
1303--LBL----51
1304--  D  ---63
1305--CNT----47
1306--FMT----42
1307--FMT----42
1308--  H  ---74
1309--PNT----45
1310--  G  ---15
1311--  a  ---13
1312--  E  ---60
1313--  A  ---62
1314--XTO----23
1315--  E  ---60
1316--  a  ---13
1317--PNT----45
1318--XTO----23
1319--  L  ---72
1320--CLR----20
1321--YTO----40
1322--  E  ---60
1323--XTO----23
1324--PNT----45
1325--  H  ---74
1326--SFL----54
1327--XTO----23
1328--  L  ---72
1329--SFL----54
1330--FMT----42
1331--PNT----45
1332--  UP---27
1333--CNT----47
1334--CNT----47
1335--CNT----47
1336--LBL----51
1337--  D  ---63
1338--CNT----47
1339--CNT----47
1340--CNT----47
1341--CNT----47
1342--CNT----47
1343--  2  ---02
1344--  X  ---36
1345--XFR----67
1346--  0  ---00
1347--  1  ---01
1348--  3  ---03
1349--  X  ---36
1350--XEY----30
1351--FMT----42
1352--FMT----42
1353--  I  ---65
1354--  N  ---73
1355--  N  ---73
1356--  E  ---60
1357--  a  ---13
1358--CNT----47
1359--  π  ---56
1360--  a  ---13
1361--  O  ---71
1362--  J  ---75
1363--  E  ---60
1364--  C  ---61
1365--XTO----23
1366--  I  ---65
1367--  O  ---71
1368--  N  ---73
1369--CNT----47
1370--  A  ---62
1371--INT----64
1372--  A  ---62
1373--  I  ---65
1374--  L  ---72
1375--  A  ---62
1376--  B  ---66
1377--  L  ---72
1378--  E  ---60
1379--PNT----45
1380--  F  ---16
1381--  O  ---71
1382--  a  ---13
1383--CLR----20
1384--PNT----45
1385--  a  ---13
1386--  E  ---60
1387--  I  ---65
1388--  N  ---73
1389--  F  ---16
1390--  O  ---71
1391--  a  ---13
1392--  C  ---61
1393--  E  ---60
1394--  M  ---70
1395--  E  ---60
1396--  N  ---73
1397--XTO----23
1398--CLR----20
1399--  A  ---62
```

```
1400--  3  ---03
1401--SFL---54
1402--FMT---42
1403--PNT---45
1404--XTO---23
1405--  0  ---00
1406--  2  ---02
1407--  2  ---02
1408--FMT---42
1409--FMT---42
1410--  L  ---72
1411--  E  ---60
1412--  N  ---73
1413--  G  ---15
1414--XTO---23
1415--  H  ---74
1416--PNT---45
1417--IND---31
1418--  E  ---60
1419--  L  ---72
1420--  D  ---63
1421--PNT---45
1422--  L  ---72
1423--  E  ---60
1424--  G  ---15
1425--YTO---40
1426--CLR---20
1427--IND---31
1428--  1  ---01
1429--SFL---54
1430--FMT---42
1431--STP---41
1432--PNT---45
1433--XTO---23
1434--  0  ---00
1435--  2  ---02
1436--  3  ---03
1437--FMT---42
1438--FMT---42
1439--IND---31
1440--  2  ---02
1441--SFL---54
1442--FMT---42
1443--STP---41
1444--PNT---45
1445--XTO---23
1446--  2  ---02
1447--  4  ---04
1448--XSQ---12
1449--  UP---27
1450--XFR---67
1451--  2  ---02
1452--  3  ---03
1453--XSQ---12
1454--  +  ---33
1455--CNT---47
1456--CNT---47
1457--XEY---30
1458--XTO---23
1459--  0  ---00
```

```
1460--  2  ---02
1461--  7  ---07
1462--FMT---42
1463--FMT---42
1464--PNT---45
1465--IND---31
1466--  E  ---60
1467--  L  ---72
1468--  D  ---63
1469--PNT---45
1470--  A  ---62
1471--INT---64
1472--  A  ---62
1473--  I  ---65
1474--  L  ---72
1475--  A  ---62
1476--  B  ---66
1477--  L  ---72
1478--  E  ---60
1479--PNT---45
1480--  E  ---16
1481--  O  ---71
1482--  a  ---13
1483--PNT---45
1484--  a  ---13
1485--  E  ---60
1486--  I  ---65
1487--  N  ---73
1488--  F  ---16
1489--  O  ---71
1490--  a  ---13
1491--  C  ---61
1492--  M  ---70
1493--  E  ---60
1494--  N  ---73
1495--XTO---23
1496--  A  ---62
1497--  4  ---04
1498--CNT---47
1499--SFL---54
1500--FMT---42
1501--PNT---45
1502--XTO---23
1503--  2  ---02
1504--  7  ---07
1505--XFR---67
1506--  0  ---00
1507--  1  ---01
1508--  9  ---11
1509--XFR---67
1510--  +  ---33
1511--  0  ---00
1512--  2  ---02
1513--  0  ---00
1514--XFR---67
1515--  +  ---33
1516--  0  ---00
1517--  2  ---02
1518--  2  ---02
1519--XFR---67
```

```
1520--  +  ---33
1521--  0  ---00
1522--  2  ---02
1523--  7  ---07
1524--FMT---42
1525--FMT---42
1526--CLR---20
1527--CLR---20
1528--CLR---20
1529--  a  ---13
1530--  E  ---60
1531--  I  ---65
1532--  N  ---73
1533--  F  ---16
1534--  O  ---71
1535--  a  ---13
1536--  C  ---61
1537--  E  ---60
1538--  D  ---63
1539--CNT---47
1540--  A  ---62
1541--  a  ---13
1542--  E  ---60
1543--  A  ---62
1544--CNT---47
1545--  M  ---56
1546--  a  ---13
1547--  O  ---71
1548--INT---64
1549--  I  ---65
1550--  D  ---63
1551--  E  ---60
1552--  D  ---63
1553--CLR---20
1554--  A  ---62
1555--YTO---40
1556--X<Y---52
1557--  A  ---62
1558--  1  ---01
1559--  +  ---33
1560--  A  ---62
1561--  2  ---02
1562--  +  ---33
1563--  A  ---62
1564--  3  ---03
1565--  +  ---33
1566--  A  ---62
1567--  4  ---04
1568--PSE---57
1569--SFL---54
1570--FMT---42
1571--PNT---45
1572--XTO---23
1573--  0  ---00
1574--  2  ---02
1575--  8  ---10
1576--  UP---27
1577--XFR---67
1578--  0  ---00
1579--  1  ---01
```

```
1580--  1  ---01
1581--CNT----47
1582--FMT----42
1583--FMT----42
1584--  A  ---62
1585--X<Y----52
1586--  a  ---13
1587--  E  ---60
1588--  b  ---14
1589--  D  ---63
1590--PSE----57
1591--SFL----54
1592--FMT----42
1593--PNT----45
1594--XEY----30
1595--X>Y----53
1596--GTO----44
1597--LBL----51
1598--  E  ---60
1599--CNT----47
1600--  1  ---01
1601--FMT----42
1602--  5  ---05
1603--CLX----37
1604--GTO----44
1605--LBL----51
1606--SFL----54
1607--CNT----47
1608--CNT----47
1609--CNT----47
1610--CNT----47
1611--CNT----47
1612--CNT----47
1613--CNT----47
1614--CNT----47
1615--LBL----51
1616--  E  ---60
1617--FMT----42
1618--FMT----42
1619--PNT----45
1620--PNT----45
1621--PNT----45
1622--YTO----40
1623--1/X----17
1624--  F  ---16
1625--  F  ---16
1626--  I  ---65
1627--  C  ---61
1628--  I  ---65
1629--  E  ---60
1630--  N  ---73
1631--XTO----23
1632--PNT----45
1633--PNT----45
1634--PNT----45
1635--PNT----45
1636--PNT----45
1637--  a  ---13
1638--  E  ---60
1639--  I  ---65
1640--  N  ---73
1641--  F  ---16
1642--  O  ---71
1643--  a  ---13
1644--  C  ---61
1645--  I  ---65
1646--  N  ---73
1647--  G  ---15
1648--FMT----42
1649--STP----41
1650--END----46
```

TAPE 1 - FILE 1

```
0020--LBL----51
0021--XFR----67
0022--FMT----42
0023--FMT----42
0024--  a  ---13
0025--  E  ---60
0026--  b  ---14
0027--  D  ---63
0028--PNT----45
0029--  a  ---13
0030--  E  ---60
0031--  ?  ---65
0032--  N  ---73
0033--  F  ---16
0034--  O  ---71
0035--  a  ---13
0036--  C  ---61
0037--  E  ---60
0038--  D  ---63
0039--PNT----45
0040--PNT----45
0041--PNT----45
0042--  A  ---62
0043--  a  ---13
0044--  E  ---60
0045--  A  ---62
0046--PNT----45
0047--  G  ---15
0048--  a  ---13
0049--  E  ---60
0050--  A  ---62
0051--XTO----23
0052--  E  ---60
0053--  a  ---13
0054--PNT----45
0055--PNT----45
0056--PNT----45
0057--XTO----23
0058--  H  ---74
0059--  A  ---62
0060--  N  ---73
0061--PNT----45
0062--  A  ---62
0063--INT----64
0064--  A  ---62
0065--  I  ---65
0066--  L  ---72
0067--  A  ---62
0068--  B  ---66
0069--  L  ---72
0070--  E  ---60
0071--PNT----45
0072--PNT----45
0073--PNT----45
0074--PNT----45
0075--PNT----45
0076--PNT----45
0077--PNT----45
0078--  A  ---62
0079--  a  ---13
0080--  E  ---60
0081--  A  ---62
0082--CLR----20
0083--CLR----20
0084--PNT----45
0085--PNT----45
0086--PNT----45
0087--  A  ---62
0088--  D  ---63
0089--  D  ---63
0090--  I  ---65
0091--XTO----23
0092--  I  ---65
0093--  O  ---71
0094--  N  ---73
0095--  A  ---62
0096--  L  ---72
0097--CLR----20
0098--PNT----45
0099--PNT----45
0100--  a  ---13
0101--  E  ---60
0102--  J  ---65
0103--  N  ---73
0104--  F  ---16
0105--  O  ---71
0106--  a  ---13
0107--  C  ---61
0108--  I  ---65
0109--  N  ---73
0110--  G  ---15
0111--CLR----20
0112--PNT----45
0113--PNT----45
0114--PNT----45
0115--PNT----45
0116--PNT----45
0117--PNT----45
0118--  a  ---13
0119--  E  ---60
```

```
0120--  6  ---14
0121--  D  ---63
0122--FMT---42
0123--CLR---20
0124--CLR---20
0125--CNT---47
0126--GTO---44
0127--LBL---51
0128--  F  ---16
0129--CNT---47
0130--LBL---51
0131--  F  ---16
0132--FMT---42
0133--FMT---42
0134--CLR---20
0135--CLR---20
0136--CLR---20
0137--  A  ---62
0138--  L  ---72
0139--  L  ---72
0140--  O  ---71
0141--IND---31
0142--  A  ---62
0143--  B  ---66
0144--  L  ---72
0145--  E  ---60
0146--CNT---47
0147--  π  ---56
0148--  A  ---62
0149--  D  ---63
0150--CNT---47
0151--CNT---47
0152--CNT---47
0153--YTO---40
0154--XTO---23
0155--  a  ---13
0156--  E  ---60
0157--YTO---40
0158--YTO---40
0159--CNT---47
0160--X<Y---52
0161--  π  ---56
0162--YTO---40
0163--  I  ---65
0164--PSE---57
0165--SFL---54
0166--FMT---42
0167--STP---41
0168--PNT---45
0169--  UP---27
0170--XFR---67
0171--  0  ---00
0172--  3  ---03
0173--DIV---35
0174--  1  ---01
0175--X<Y---52
0176--GTO---44
0177--LBL---51
0178--  G  ---15
0179--CNT---47
```

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```
0180--XEY---30
0181--LBL---51
0182--  G  ---15
0183--XTO---23
0184--  3  ---03
0185--  3  ---03
0186--FMT---42
0187--FMT---42
0188--  a  ---13
0189--  E  ---60
0190--  I  ---65
0191--  N  ---73
0192--  F  ---16
0193--  O  ---71
0194--  a  ---13
0195--  C  ---61
0196--  I  ---65
0197--  N  ---73
0198--  G  ---15
0199--CNT---47
0200--  π  ---56
0201--  A  ---62
0202--  D  ---63
0203--CNT---47
0204--XTO---23
0205--  H  ---74
0206--  I  ---65
0207--  C  ---61
0208--  K  ---55
0209--  N  ---73
0210--  E  ---60
0211--YTO---40
0212--YTO---40
0213--CLR---20
0214--XTO---23
0215--  E  ---60
0216--X<Y---52
0217--  O  ---71
0218--1/X---17
0219--XTO---23
0220--YTO---40
0221--  I  ---65
0222--  D  ---63
0223--  E  ---60
0224--PSE---57
0225--SFL---54
0226--FMT---42
0227--STP---41
0228--PNT---45
0229--XTO---23
0230--  0  ---00
0231--  1  ---01
0232--  4  ---04
0233--FMT---42
0234--FMT---42
0235--XTO---23
0236--  E  ---60
0237--X<Y---52
0238--  I  ---65
0239--  N  ---73
```

```
0240--YTO---40
0241--  I  ---65
0242--  D  ---63
0243--  E  ---60
0244--PSE---57
0245--SFL---54
0246--FMT---42
0247--STP---41
0248--PNT---45
0249--XTO---23
0250--  0  ---00
0251--  3  ---03
0252--  0  ---00
0253--FMT---42
0254--FMT---42
0255--CLR---20
0256--  a  ---13
0257--  E  ---60
0258--  I  ---65
0259--  N  ---73
0260--  F  ---16
0261--  O  ---71
0262--  a  ---13
0263--  C  ---61
0264--  E  ---60
0265--  M  ---70
0266--  E  ---60
0267--  N  ---73
0268--XTO---23
0269--CLR---20
0270--  L  ---72
0271--  I  ---65
0272--  M  ---70
0273--  I  ---65
0274--XTO---23
0275--YTO---40
0276--CLR---20
0277--CNT---47
0278--CNT---47
0279--CNT---47
0280--CNT---47
0281--CNT---47
0282--CNT---47
0283--CNT---47
0284--CNT---47
0285--CNT---47
0286--CNT---47
0287--CNT---47
0288--CNT---47
0289--CNT---47
0290--CNT---47
0291--CNT---47
0292--CNT---47
0293--  π  ---56
0294--  A  ---62
0295--  a  ---13
0296--  A  ---62
0297--  L  ---72
0298--  L  ---72
0299--  E  ---60
```

```
0300-- L ---72
0301--CNT---47
0302--XTO---23
0303-- 0 ---71
0304--CLR---20
0305--INT---64
0306-- E ---60
0307--YTO---40
0308--YTO---40
0309-- E ---60
0310-- L ---72
0311--CNT---47
0312--IND---31
0313-- A ---62
0314-- L ---72
0315-- L ---72
0316--FMT---42
0317-- 2 ---02
0318--XFR---67
0319-- X ---36
0320-- 0 ---00
0321-- 0 ---00
0322-- 9 ---11
0323-- UP---27
0324--XFR---67
0325-- 0 ---00
0326-- 0 ---00
0327-- 9 ---11
0328-- UP---27
0329-- 2 ---02
0330--DIV---35
0331--XFR---67
0332-- 0 ---00
0333-- 1 ---01
0334-- 2 ---02
0335-- + ---33
0336--XFR---67
0337-- 0 ---00
0338-- 1 ---01
0339-- 3 ---03
0340-- + ---33
0341-- 2 ---02
0342-- X ---36
0343-- DN---25
0344--X>Y---53
0345--GTO---44
0346--LBL---51
0347-- H ---74
0348--CNT---47
0349--XEY---30
0350--LBL---51
0351-- H ---74
0352--FMT---42
0353--FMT---42
0354-- D ---63
0355-- L ---72
0356--SFL---54
0357--FMT---42
0358--PNT---45
0359--XTO---23
0360-- 0 ---00
0361-- 1 ---01
0362-- 5 ---05
0363-- 2 ---02
0364-- . ---21
0365-- 5 ---05
0366-- UP---27
0367--XFR---67
0368-- 0 ---00
0369-- 1 ---01
0370-- 2 ---02
0371-- X ---36
0372-- 2 ---02
0373-- . ---21
0374-- 5 ---05
0375--XFR---67
0376-- X ---36
0377-- 0 ---00
0378-- 1 ---01
0379-- 3 ---03
0380--XFR---67
0381-- + ---33
0382-- 0 ---00
0383-- 1 ---01
0384-- 4 ---04
0385--X<Y---52
0386--GTO---44
0387--LBL---51
0388-- I ---65
0389--CNT---47
0390--XEY---30
0391--LBL---51
0392-- I ---65
0393--FMT---42
0394--FMT---42
0395-- N ---73
0396-- O ---71
0397-- a ---13
0398-- M ---70
0399-- A ---62
0400-- L ---72
0401--CNT---47
0402--XTO---23
0403-- O ---71
0404--CNT---47
0405--INT---64
0406-- E ---60
0407--YTO---40
0408--YTO---40
0409-- E ---60
0410-- L ---72
0411--IND---31
0412-- A ---62
0413-- L ---72
0414-- L ---72
0415--CLR---20
0416--XTO---23
0417-- L ---72
0418--X<Y---52
0419-- O ---71
0420--1/X---17
0421--XTO---23
0422--YTO---40
0423-- I ---65
0424-- D ---63
0425-- E ---60
0426--PSE---57
0427--SFL---54
0428--FMT---42
0429--PNT---45
0430--XTO---23
0431-- 0 ---00
0432-- 1 ---01
0433-- 6 ---06
0434-- 2 ---02
0435-- . ---21
0436-- 5 ---05
0437-- UP---27
0438--XFR---67
0439-- 0 ---00
0440-- 1 ---01
0441-- 2 ---02
0442-- X ---36
0443-- 2 ---02
0444-- . ---21
0445-- 5 ---05
0446--XFR---67
0447-- X ---36
0448-- 0 ---00
0449-- 1 ---01
0450-- 3 ---03
0451--XFR---67
0452-- + ---33
0453-- 0 ---00
0454-- 3 ---03
0455-- 0 ---00
0456--X<Y---52
0457--GTO---44
0458--LBL---51
0459-- J ---75
0460--CNT---47
0461--XEY---30
0462--LBL---51
0463-- J ---75
0464--FMT---42
0465--FMT---42
0466--XTO---23
0467-- L ---72
0468--X<Y---52
0469-- I ---65
0470-- N ---73
0471--YTO---40
0472-- I ---65
0473-- D ---63
0474-- E ---60
0475--PSE---57
0476--SFL---54
0477--FMT---42
0478--PNT---45
0479--XTO---23
```

```
0480--  0  ---00
0481--  3  ---03
0482--  5  ---05
0483--XFR---67
0484--  0  ---00
0485--  1  ---01
0486--  4  ---04
0487--  UP---27
0488--XFR---67
0489--  0  ---00
0490--  1  ---01
0491--  6  ---06
0492--X>Y---53
0493--GTO---44
0494--LBL---51
0495--  K  ---55
0496--CNT---47
0497--CNT---47
0498--FMT---42
0499--FMT---42
0500--PNT---45
0501--PNT---45
0502--XTO---23
0503--  E  ---60
0504--X<Y---52
0505--  O  ---71
0506--1/X---17
0507--XTO---23
0508--YTO---40
0509--  I  ---65
0510--  D  ---63
0511--  E  ---60
0512--PSE---57
0513--PNT---45
0514--PNT---45
0515--CLR---20
0516--PNT---45
0517--PNT---45
0518--  G  ---15
0519--  a  ---13
0520--  E  ---60
0521--  A  ---62
0522--XTO---23
0523--  E  ---60
0524--  a  ---13
0525--PNT---45
0526--XTO---23
0527--  H  ---74
0528--  A  ---62
0529--  N  ---73
0530--CLR---20
0531--PNT---45
0532--PNT---45
0533--XTO---23
0534--  L  ---72
0535--X<Y---52
0536--  O  ---71
0537--1/X---17
0538--XTO---23
0539--YTO---40
```



```
0540--  I  ---65
0541--  D  ---63
0542--  E  ---60
0543--PSE---57
0544--PNT---45
0545--PNT---45
0546--CLR---20
0547--YTO---40
0548--  E  ---60
0549--XTO---23
0550--PNT---45
0551--XTO---23
0552--  E  ---60
0553--SFL---54
0554--XTO---23
0555--  L  ---72
0556--SFL---54
0557--FMT---42
0558--CNT---47
0559--PNT---45
0560--XTO---23
0561--  0  ---00
0562--  1  ---01
0563--  4  ---04
0564--GTO---44
0565--LBL---51
0566--  L  ---72
0567--CNT---47
0568--CNT---47
0569--LBL---51
0570--  K  ---55
0571--XEY---30
0572--XTO---23
0573--  0  ---00
0574--  1  ---01
0575--  4  ---04
0576--LBL---51
0577--  L  ---72
0578--XFR---67
0579--  0  ---00
0580--  3  ---03
0581--  0  ---00
0582--  UP---27
0583--XFR---67
0584--  0  ---00
0585--  3  ---03
0586--  5  ---05
0587--X>Y---53
0588--GTO---44
0589--LBL---51
0590--  M  ---70
0591--CNT---47
0592--FMT---42
0593--FMT---42
0594--PNT---45
0595--PNT---45
0596--PNT---45
0597--XTO---23
0598--  E  ---60
0599--X<Y---52
```

```
0600--  I  ---65
0601--  N  ---73
0602--YTO---40
0603--  I  ---65
0604--  D  ---63
0605--  E  ---60
0606--PSE---57
0607--CLR---20
0608--PNT---45
0609--  G  ---15
0610--  a  ---13
0611--  E  ---60
0612--  A  ---62
0613--XTO---23
0614--  E  ---60
0615--  a  ---13
0616--PNT---45
0617--XTO---23
0618--  H  ---74
0619--  A  ---62
0620--  N  ---73
0621--CLR---20
0622--PNT---45
0623--PNT---45
0624--PNT---45
0625--XTO---23
0626--  L  ---72
0627--X<Y---52
0628--  I  ---65
0629--  N  ---73
0630--YTO---40
0631--  I  ---65
0632--  D  ---63
0633--  E  ---60
0634--PSE---57
0635--CLR---20
0636--YTO---40
0637--  E  ---60
0638--XTO---23
0639--PNT---45
0640--XTO---23
0641--  E  ---60
0642--SFL---54
0643--XTO---23
0644--  L  ---72
0645--SFL---54
0646--FMT---42
0647--CNT---47
0648--PNT---45
0649--XTO---23
0650--  0  ---00
0651--  3  ---03
0652--  0  ---00
0653--GTO---44
0654--LBL---51
0655--  N  ---73
0656--CNT---47
0657--LBL---51
0658--  M  ---70
0659--XEY---30
```

```
0660--XTO---23
0661--  0  ---00
0662--  3  ---03
0663--  0  ---00
0664--XFR---67
0665--  0  ---00
0666--  2  ---02
0667--  1  ---01
0668--  UP--27
0669--XFR---67
0670--  0  ---00
0671--  3  ---03
0672--  5  ---05
0673--X>Y---53
0674--GTO---44
0675--LBL---51
0676--RUP---22
0677--CNT---47
0678--FMT---42
0679--FMT---42
0680--  H  ---74
0681--CNT---47
0682--  G  ---15
0683--XTO---23
0684--  α  ---13
0685--CNT---47
0686--XTO---23
0687--  L  ---72
0688--X<Y---52
0689--  I  ---65
0690--  N  ---73
0691--YTO---40
0692--  I  ---65
0693--  D  ---63
0694--  E  ---60
0695--PSE---57
0696--YTO---40
0697--  E  ---60
0698--XTO---23
0699--CNT---47
0700--  H  ---74
0701--SFL---54
0702--XTO---23
0703--  L  ---72
0704--SFL---54
0705--FMT---42
0706--PNT---45
0707--  UP--27
0708--LBL---51
0709--RUP---22
0710--XFR---67
0711--  1  ---01
0712--  3  ---03
0713--  X  ---36
0714--  2  ---02
0715--  X  ---36
0716--  DN--25
0717--FMT---42
0718--FMT---42
0719--CLR---20
0720--  I  ---65
0721--  N  ---73
0722--  N  ---73
0723--  E  ---60
0724--  α  ---13
0725--CNT---47
0726--  π  ---56
0727--  α  ---13
0728--  O  ---71
0729--  J  ---75
0730--  E  ---60
0731--  C  ---61
0732--XTO---23
0733--  I  ---65
0734--  O  ---71
0735--  N  ---73
0736--CNT---47
0737--  A  ---62
0738--INT---64
0739--  A  ---62
0740--  I  ---65
0741--  L  ---72
0742--  A  ---62
0743--  B  ---66
0744--  L  ---72
0745--  E  ---60
0746--CNT---47
0747--  F  ---16
0748--  O  ---71
0749--  α  ---13
0750--CNT---47
0751--CNT---47
0752--CNT---47
0753--  α  ---13
0754--  E  ---60
0755--  I  ---65
0756--  N  ---73
0757--  F  ---16
0758--  O  ---71
0759--  α  ---13
0760--  C  ---61
0761--  E  ---60
0762--  M  ---70
0763--  E  ---60
0764--  N  ---73
0765--XTO---23
0766--CLR---20
0767--  A  ---62
0768--  3  ---03
0769--  X  ---36
0770--SFL---54
0771--FMT---42
0772--PNT---45
0773--XTO---23
0774--  2  ---02
0775--  2  ---02
0776--LBL---51
0777--  N  ---73
0778--FMT---42
0779--FMT---42
0780--  D  ---63
0781--  I  ---65
0782--  A  ---62
0783--  M  ---70
0784--  E  ---60
0785--XTO---23
0786--  E  ---60
0787--  α  ---13
0788--CNT---47
0789--  O  ---71
0790--  F  ---16
0791--CLR---20
0792--  α  ---13
0793--  E  ---60
0794--  I  ---65
0795--  N  ---73
0796--  F  ---16
0797--  O  ---71
0798--  α  ---13
0799--  C  ---61
0800--  I  ---65
0801--  N  ---73
0802--  G  ---15
0803--CNT---47
0804--  π  ---56
0805--  A  ---62
0806--  D  ---63
0807--CNT---47
0808--  D  ---63
0809--  π  ---56
0810--X<Y---52
0811--  O  ---71
0812--1/X---17
0813--XTO---23
0814--YTO---40
0815--  I  ---65
0816--  D  ---63
0817--  E  ---60
0818--PSE---57
0819--SFL---54
0820--FMT---42
0821--STP---41
0822--PNT---45
0823--XTO---23
0824--  0  ---00
0825--  3  ---03
0826--  7  ---07
0827--FMT---42
0828--FMT---42
0829--  D  ---63
0830--  π  ---56
0831--X<Y---52
0832--  I  ---65
0833--  N  ---73
0834--YTO---40
0835--  I  ---65
0836--  D  ---63
0837--  E  ---60
0838--PSE---57
0839--SFL---54
```

```
0840--FMT---42
0841--STP---41
0842--PNT---45
0843--XTO---23
0844--  0   ---00
0845--  3   ---03
0846--  8   ---10
0847--XFR---67
0848--  0   ---00
0849--  3   ---03
0850--  7   ---07
0851--  UP  ---27
0852--XFR---67
0853--  0   ---00
0854--  1   ---01
0855--  5   ---05
0856--X>Y---53
0857--GTO---44
0858--LBL---51
0859--  0   ---71
0860--CNT---47
0861--FMT---42
0862--FMT---42
0863--  D   ---63
0864--  π   ---56
0865--X<Y---52
0866--  0   ---71
0867--1/X---17
0868--XTO---23
0869--YTO---40
0870--  I   ---65
0871--  D   ---63
0872--  E   ---60
0873--PSE---57
0874--PNT---45
0875--  G   ---15
0876--XTO---23
0877--  α   ---13
0878--CLR---20
0879--PNT---45
0880--PNT---45
0881--PNT---45
0882--  D   ---63
0883--  L   ---72
0884--X<Y---52
0885--  0   ---71
0886--1/X---17
0887--XTO---23
0888--YTO---40
0889--  I   ---65
0890--  D   ---63
0891--  E   ---60
0892--PSE---57
0893--CLR---20
0894--YTO---40
0895--  E   ---60
0896--XTO---23
0897--PNT---45
0898--  D   ---63
0899--  π   ---56
```

```
0900--SFL---54
0901--  D   ---63
0902--  L   ---72
0903--SFL---54
0904--FMT---42
0905--PNT---45
0906--XTO---23
0907--  0   ---00
0908--  3   ---03
0909--  7   ---07
0910--GTO---44
0911--LBL---51
0912--  b   ---14
0913--CNT---47
0914--LBL---51
0915--  0   ---71
0916--XEY---30
0917--XTO---23
0918--  0   ---00
0919--  3   ---03
0920--  7   ---07
0921--LBL---51
0922--  b   ---14
0923--XFR---67
0924--  0   ---00
0925--  3   ---03
0926--  8   ---10
0927--  UP  ---27
0928--XFR---67
0929--  0   ---00
0930--  1   ---01
0931--  5   ---05
0932--X>Y---53
0933--GTO---44
0934--LBL---51
0935--  α   ---13
0936--CNT---47
0937--FMT---42
0938--FMT---42
0939--  D   ---63
0940--  π   ---56
0941--X<Y---52
0942--  I   ---65
0943--  N   ---73
0944--YTO---40
0945--  I   ---65
0946--  D   ---63
0947--  E   ---60
0948--PSE---57
0949--PNT---45
0950--  G   ---15
0951--XTO---23
0952--  α   ---13
0953--CLR---20
0954--PNT---45
0955--PNT---45
0956--PNT---45
0957--PNT---45
0958--  D   ---63
0959--  L   ---72
```

```
0960--X<Y---52
0961--  I   ---65
0962--  N   ---73
0963--YTO---40
0964--  I   ---65
0965--  D   ---63
0966--  E   ---60
0967--PSE---57
0968--CLR---20
0969--YTO---40
0970--  E   ---60
0971--XTO---23
0972--PNT---45
0973--  D   ---63
0974--  π   ---56
0975--SFL---54
0976--  D   ---63
0977--  L   ---72
0978--SFL---54
0979--FMT---42
0980--PNT---45
0981--XTO---23
0982--  0   ---00
0983--  3   ---03
0984--  8   ---10
0985--GTO---44
0986--LBL---51
0987--YTO---40
0988--CNT---47
0989--CNT---47
0990--LBL---51
0991--  α   ---13
0992--XEY---30
0993--XTO---23
0994--  0   ---00
0995--  3   ---03
0996--  8   ---10
0997--LBL---51
0998--YTO---40
0999--XFR---67
1000--  0   ---00
1001--  3   ---03
1002--  7   ---07
1003--XFR---67
1004--  -   ---34
1005--  0   ---00
1006--  0   ---00
1007--  9   ---11
1008--  UP  ---27
1009--  2   ---02
1010--  UP  ---27
1011--XFR---67
1012--  0   ---00
1013--  1   ---01
1014--  3   ---03
1015--  X   ---36
1016--  DN  ---25
1017--  -   ---34
1018--  DN  ---25
1019--XFR---67
```

```
1020--  X  ---36
1021--  0  ---00
1022--  3  ---03
1023--  3  ---03
1024--XFR---67
1025--  X  ---36
1026--  0  ---00
1027--  1  ---01
1028--  4  ---04
1029--FMT---42
1030--FMT---42
1031--  A  ---62
1032--  5  ---05
1033--X<Y---52
1034--  0  ---71
1035--1/X---17
1036--XTO---23
1037--YTO---40
1038--  I  ---65
1039--  D  ---63
1040--  E  ---60
1041--PSE---57
1042--SFL---54
1043--FMT---42
1044--PNT---45
1045--XTO---23
1046--  0  ---00
1047--  3  ---03
1048--  9  ---11
1049--XFR---67
1050--  0  ---00
1051--  3  ---03
1052--  8  ---10
1053--XFR---67
1054--  -  ---34
1055--  0  ---00
1056--  0  ---00
1057--  9  ---11
1058--  UP  --27
1059--  2  ---02
1060--  UP  --27
1061--XFR---67
1062--  0  ---00
1063--  1  ---01
1064--  3  ---03
1065--  X  ---36
1066--  DN  --25
1067--  -  ---34
1068--  DN  --25
1069--XFR---67
1070--  X  ---36
1071--  0  ---00
1072--  3  ---03
1073--  3  ---03
1074--XFR---67
1075--  X  ---36
1076--  0  ---00
1077--  3  ---03
1078--  0  ---00
1079--FMT---42
1080--FMT---42
1081--  A  ---62
1082--  5  ---05
1083--X<Y---52
1084--  I  ---65
1085--  N  ---73
1086--YTO---40
1087--  I  ---65
1088--  D  ---63
1089--  E  ---60
1090--PSE---57
1091--SFL---54
1092--FMT---42
1093--PNT---45
1094--XTO---23
1095--  0  ---00
1096--  4  ---04
1097--  0  ---00
1098--FMT---42
1099--FMT---42
1100--IND---31
1101--  E  ---60
1102--  L  ---72
1103--  D  ---63
1104--PNT---45
1105--  L  ---72
1106--  E  ---60
1107--  G  ---15
1108--PNT---45
1109--  L  ---72
1110--  E  ---60
1111--  N  ---73
1112--  G  ---15
1113--XTO---23
1114--  H  ---74
1115--CLR---20
1116--IND---31
1117--  1  ---01
1118--SFL---54
1119--FMT---42
1120--STP---41
1121--PNT---45
1122--XTO---23
1123--  0  ---00
1124--  2  ---02
1125--  3  ---03
1126--FMT---42
1127--FMT---42
1128--IND---31
1129--  2  ---02
1130--SFL---54
1131--FMT---42
1132--STP---41
1133--PNT---45
1134--XTO---23
1135--  0  ---00
1136--  2  ---02
1137--  4  ---04
1138--FMT---42
1139--FMT---42
1140--IND---31
1141--  3  ---03
1142--SFL---54
1143--FMT---42
1144--STP---41
1145--PNT---45
1146--XTO---23
1147--  0  ---00
1148--  2  ---02
1149--  5  ---05
1150--FMT---42
1151--FMT---42
1152--IND---31
1153--  4  ---04
1154--SFL---54
1155--FMT---42
1156--STP---41
1157--PNT---45
1158--XTO---23
1159--  0  ---00
1160--  2  ---02
1161--  6  ---06
1162--XFR---67
1163--  1  ---01
1164--  4  ---04
1165--  UP  --27
1166--XFR---67
1167--  1  ---01
1168--  6  ---06
1169--X>Y---53
1170--GTO---44
1171--LBL---51
1172--  +  ---33
1173--CNT---47
1174--FMT---42
1175--FMT---42
1176--CLR---20
1177--IND---31
1178--  1  ---01
1179--CNT---47
1180--  0  ---71
1181--1/X---17
1182--XTO---23
1183--YTO---40
1184--  I  ---65
1185--  D  ---63
1186--  E  ---60
1187--CNT---47
1188--  L  ---72
1189--  I  ---65
1190--  M  ---70
1191--  I  ---65
1192--XTO---23
1193--  0  ---71
1194--  F  ---16
1195--CNT---47
1196--  a  ---13
1197--  E  ---60
1198--  I  ---65
1199--  N  ---73
```

```
1200-- F ---16
1201-- 0 ---71
1202-- a ---13
1203-- C ---61
1204-- E ---60
1205-- M ---70
1206-- E ---60
1207-- N ---73
1208--XTO---23
1209--X<Y---52
1210-- N ---73
1211-- 0 ---71
1212--XTO---23
1213--CNT---47
1214-- C ---61
1215-- 0 ---71
1216-- N ---73
1217--YTO---40
1218-- I ---65
1219-- D ---63
1220-- E ---60
1221-- a ---13
1222-- E ---60
1223-- D ---63
1224--PSE---57
1225--FMT---42
1226-- 0 ---00
1227--XTO---23
1228-- 0 ---00
1229-- 2 ---02
1230-- 3 ---03
1231--LBL---51
1232-- + ---33
1233--XFR---67
1234-- 3 ---03
1235-- 0 ---00
1236-- UP---27
1237--XFR---67
1238-- 3 ---03
1239-- 5 ---05
1240--X>Y---53
1241--GTO---44
1242--LBL---51
1243-- 1 ---01
1244--CNT---47
1245--FMT---42
1246--FMT---42
1247--CLR---20
1248--IND---31
1249-- 2 ---02
1250--CNT---47
1251-- 0 ---71
1252--1/X---17
1253--XTO---23
1254--YTO---40
1255-- I ---65
1256-- D ---63
1257-- E ---60
1258--CNT---47
1259-- L ---72
1260-- I ---65
1261-- M ---70
1262-- I ---65
1263--XTO---23
1264-- 0 ---71
1265-- F ---16
1266--CNT---47
1267-- a ---13
1268-- E ---60
1269-- I ---65
1270-- N ---73
1271-- F ---16
1272-- 0 ---71
1273-- a ---13
1274-- C ---61
1275-- E ---60
1276-- M ---70
1277-- E ---60
1278-- N ---73
1279--XTO---23
1280--X<Y---52
1281-- N ---73
1282-- 0 ---71
1283--XTO---23
1284--CNT---47
1285-- C ---61
1286-- 0 ---71
1287-- N ---73
1288--YTO---40
1289-- I ---65
1290-- D ---63
1291-- E ---60
1292-- a ---13
1293-- E ---60
1294-- D ---63
1295--PSE---57
1296--FMT---42
1297-- 0 ---00
1298--XTO---23
1299-- 0 ---00
1300-- 2 ---02
1301-- 4 ---04
1302--LBL---51
1303-- 1 ---01
1304--XFR---67
1305-- 3 ---03
1306-- 7 ---07
1307-- UP---27
1308--XFR---67
1309-- 1 ---01
1310-- 5 ---05
1311--X>Y---53
1312--GTO---44
1313--LBL---51
1314-- 2 ---02
1315--CNT---47
1316--FMT---42
1317--FMT---42
1318--CLR---20
1319--IND---31
1320-- 3 ---03
1321--CNT---47
1322-- 0 ---71
1323--1/X---17
1324--XTO---23
1325--YTO---40
1326-- I ---65
1327-- D ---63
1328-- E ---60
1329--CNT---47
1330-- L ---72
1331-- I ---65
1332-- M ---70
1333-- I ---65
1334--XTO---23
1335-- 0 ---71
1336-- F ---16
1337--CNT---47
1338-- a ---13
1339-- E ---60
1340-- I ---65
1341-- N ---73
1342-- F ---16
1343-- 0 ---71
1344-- a ---13
1345-- C ---61
1346-- E ---60
1347-- M ---70
1348-- E ---60
1349-- N ---73
1350--XTO---23
1351--X<Y---52
1352-- N ---73
1353-- 0 ---71
1354--XTO---23
1355--CNT---47
1356-- C ---61
1357-- 0 ---71
1358-- N ---73
1359--YTO---40
1360-- I ---65
1361-- D ---63
1362-- E ---60
1363-- a ---13
1364-- E ---60
1365-- D ---63
1366--PSE---57
1367--FMT---42
1368-- 0 ---00
1369--XTO---23
1370-- 0 ---00
1371-- 2 ---02
1372-- 5 ---05
1373--LBL---51
1374-- 2 ---02
1375--XFR---67
1376-- 3 ---03
1377-- 9 ---10
1378-- UP---27
1379--XFR---67
```

```
1380--  1  ---01
1381--  5  ---05
1382--X>Y---53
1383--GTO---44
1384--LBL---51
1385--  3  ---03
1386--CNT---47
1387--FMT---42
1388--FMT---42
1389--CLR---20
1390--IND---31
1391--  4  ---04
1392--CNT---47
1393--  0  ---71
1394--1/X---17
1395--XTO---23
1396--YTO---40
1397--  I  ---65
1398--  D  ---63
1399--  E  ---60
1400--CNT---47
1401--  L  ---72
1402--  I  ---65
1403--  M  ---70
1404--  I  ---65
1405--XTO---23
1406--  O  ---71
1407--  F  ---16
1408--CNT---47
1409--  a  ---13
1410--  E  ---60
1411--  I  ---65
1412--  N  ---73
1413--  F  ---16
1414--  O  ---71
1415--  a  ---13
1416--  C  ---61
1417--  E  ---60
1418--  M  ---70
1419--  E  ---60
1420--  N  ---73
1421--XTO---23
1422--X<Y---52
1423--  N  ---73
1424--  O  ---71
1425--XTO---23
1426--CNT---47
1427--  C  ---61
1428--  O  ---71
1429--  N  ---73
1430--YTO---40
1431--  I  ---65
1432--  D  ---63
1433--  E  ---60
1434--  a  ---13
1435--  E  ---60
1436--  D  ---63
1437--PSE---57
1438--FMT---42
1439--  0  ---00
1440--XTO---23
1441--  0  ---00
1442--  2  ---02
1443--  6  ---06
1444--LBL---51
1445--  3  ---03
1446--XFR---67
1447--  2  ---02
1448--  3  ---03
1449--XSQ---12
1450--  UP---27
1451--XFR---67
1452--  0  ---00
1453--  2  ---02
1454--  4  ---04
1455--XSQ---12
1456--  +  ---33
1457--XFR---67
1458--  0  ---00
1459--  2  ---02
1460--  5  ---05
1461--XSQ---12
1462--  +  ---33
1463--XFR---67
1464--  0  ---00
1465--  2  ---02
1466--  6  ---06
1467--XSQ---12
1468--  +  ---33
1469--CNT---47
1470--CNT---47
1471--  DN---25
1472--FMT---42
1473--FMT---42
1474--CLR---20
1475--IND---31
1476--  E  ---60
1477--  L  ---72
1478--  D  ---63
1479--PNT---45
1480--  A  ---62
1481--INT---64
1482--  A  ---62
1483--  I  ---65
1484--  L  ---72
1485--  A  ---62
1486--  B  ---66
1487--  L  ---72
1488--  E  ---60
1489--CLR---20
1490--  F  ---16
1491--  O  ---71
1492--  a  ---13
1493--PNT---45
1494--  a  ---13
1495--  E  ---60
1496--  I  ---65
1497--  N  ---73
1498--  F  ---16
1499--  O  ---71
1500--  a  ---13
1501--  C  ---61
1502--  M  ---70
1503--  E  ---60
1504--  N  ---73
1505--XTO---23
1506--  A  ---62
1507--  4  ---04
1508--  X  ---36
1509--SFL---54
1510--FMT---42
1511--PNT---45
1512--XTO---23
1513--  2  ---02
1514--  7  ---07
1515--XFR---67
1516--  1  ---01
1517--  3  ---03
1518--XFR---67
1519--  -  ---34
1520--  0  ---10
1521--XTO---23
1522--  4  ---04
1523--  2  ---02
1524--XFR---67
1525--  X  ---36
1526--  1  ---01
1527--  2  ---02
1528--  UP---27
1529--  5  ---05
1530--  X  ---36
1531--YTO---40
1532--  4  ---04
1533--  1  ---01
1534--XFR---67
1535--  4  ---04
1536--  2  ---02
1537--  UP---27
1538--  2  ---02
1539--  X  ---36
1540--  2  ---02
1541--  .  ---21
1542--  5  ---05
1543--XFR---67
1544--  X  ---36
1545--  1  ---01
1546--  3  ---03
1547--  UP---27
1548--XFR---67
1549--  1  ---01
1550--  4  ---04
1551--  +  ---33
1552--  DN---25
1553--  X  ---36
1554--YTO---40
1555--  4  ---04
1556--  3  ---03
1557--XFR---67
1558--  0  ---00
1559--  4  ---04
```

```
1560--  1  ---01
1561--X<Y---52
1562--GTO---44
1563--LBL---51
1564--  DN---25
1565--CNT---47
1566--XEY---30
1567--LBL---51
1568--  DN---25
1569--FMT---42
1570--FMT---42
1571--  N  ---73
1572--  O  ---71
1573--XS0---12
1574--  .  ---21
1575--CNT---47
1576--IND---31
1577--  A  ---62
1578--  L  ---72
1579--  L  ---72
1580--CNT---47
1581--  A  ---62
1582--INT---64
1583--  A  ---62
1584--  I  ---65
1585--  L  ---72
1586--CNT---47
1587--  F  ---16
1588--  O  ---71
1589--  a  ---13
1590--CNT---47
1591--  a  ---13
1592--  E  ---60
1593--  I  ---65
1594--  N  ---73
1595--  F  ---16
1596--  O  ---71
1597--  a  ---13
1598--  C  ---61
1599--  M  ---70
1600--  E  ---60
1601--  N  ---73
1602--XTO---23
1603--  A  ---62
1604--  2  ---02
1605--  X  ---36
1606--SFL---54
1607--FMT---42
1608--PNT---45
1609--  UP---27
1610--XFR---67
1611--  1  ---01
1612--  9  ---11
1613--  +  ---33
1614--XFR---67
1615--  2  ---02
1616--  2  ---02
1617--  +  ---33
1618--XFR---67
1619--  2  ---02
```

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```
1620--  7  ---07
1621--  +  ---33
1622--XFR---67
1623--  3  ---03
1624--  9  ---11
1625--  +  ---33
1626--XFR---67
1627--  4  ---04
1628--  0  ---00
1629--  +  ---33
1630--XEY---30
1631--FMT---42
1632--FMT---42
1633--  A  ---62
1634--X<Y---52
1635--YTO---40
1636--1/X---17
1637--  M  ---70
1638--PSE---57
1639--SFL---54
1640--CLR---20
1641--X<Y---52
1642--  A  ---62
1643--  1  ---01
1644--  +  ---33
1645--  A  ---62
1646--  2  ---02
1647--  X  ---36
1648--  +  ---33
1649--  A  ---62
1650--  3  ---03
1651--  X  ---36
1652--  +  ---33
1653--  A  ---62
1654--  4  ---04
1655--  X  ---36
1656--  +  ---33
1657--  A  ---62
1658--  5  ---05
1659--X<Y---52
1660--  O  ---71
1661--1/X---17
1662--XTO---23
1663--PSE---57
1664--  +  ---33
1665--  A  ---62
1666--  5  ---05
1667--X<Y---52
1668--  I  ---65
1669--  N  ---73
1670--PSE---57
1671--PSE---57
1672--SFL---54
1673--FMT---42
1674--PNT---45
1675--  UP---27
1676--XFR---67
1677--  1  ---01
1678--  1  ---01
1679--FMT---42
```

```
1680--FMT---42
1681--  A  ---62
1682--X<Y---52
1683--  a  ---13
1684--  E  ---60
1685--  b  ---14
1686--  D  ---63
1687--PSE---57
1688--SFL---54
1689--FMT---42
1690--PNT---45
1691--X>Y---53
1692--GTO---44
1693--LBL---51
1694--XFR---67
1695--CNT---47
1696--FMT---42
1697--FMT---42
1698--CNT---47
1699--CNT---47
1700--CNT---47
1701--YTO---40
1702--1/X---17
1703--  F  ---16
1704--  F  ---16
1705--  I  ---65
1706--  C  ---61
1707--  I  ---65
1708--  E  ---60
1709--  N  ---73
1710--XTO---23
1711--CLR---20
1712--CNT---47
1713--CNT---47
1714--  a  ---13
1715--  E  ---60
1716--  I  ---65
1717--  N  ---73
1718--  F  ---16
1719--  O  ---71
1720--  a  ---13
1721--  C  ---61
1722--  I  ---65
1723--  N  ---73
1724--  G  ---15
1725--CLR---20
1726--CLR---20
1727--CLR---20
1728--CLR---20
1729--CLR---20
1730--  I  ---65
1731--  F  ---16
1732--CNT---47
1733--  a  ---13
1734--  E  ---60
1735--  I  ---65
1736--  N  ---73
1737--  F  ---16
1738--  O  ---71
1739--  a  ---13
```

```
1740--  C  ---61
1741--  E  ---60
1742--  M  ---70
1743--  E  ---60
1744--  N  ---73
1745--XTO----23
1746--CNT----47
1747--CNT----47
1748--  I  ---65
1749--YTO----40
1750--CNT----47
1751--XTO----23
1752--  O  ---71
1753--  O  ---71
1754--CNT----47
1755--  G  ---15
1756--  a  ---13
1757--  E  ---60
1758--  A  ---62
1759--XTO----23
1760--CNT----47
1761--CNT----47
1762--CNT----47
1763--CNT----47
1764--  D  ---63
1765--  E  ---60
1766--YTO----40
1767--  I  ---65
1768--  G  ---15
1769--  N  ---73
1770--  E  ---60
1771--  a  ---13
1772--CNT----47
1773--  M  ---70
1774--  A  ---62
1775--XFR----67
1776--CNT----47
1777--CNT----47
1778--CNT----47
1779--CNT----47
1780--CNT----47
1781--  O  ---71
1782--  π  ---56
1783--XTO----23
1784--  I  ---65
1785--  M  ---70
1786--  I  ---65
1787--XSO----12
1788--  E  ---60
1789--CNT----47
1790--  B  ---66
1791--XFR----67
1792--CNT----47
1793--CNT----47
1794--CNT----47
1795--CNT----47
1796--INT----64
1797--  A  ---62
1798--  a  ---13
1799--XFR----67
1800--  I  ---65
1801--  N  ---73
1802--  G  ---15
1803--CNT----47
1804--  π  ---56
1805--  A  ---62
1806--  D  ---63
1807--X<Y----52
1808--YTO----40
1809--PSE----57
1810--CNT----47
1811--CNT----47
1812--CNT----47
1813--CNT----47
1814--  π  ---56
1815--  A  ---62
1816--  a  ---13
1817--  A  ---62
1818--  M  ---70
1819--  E  ---60
1820--XTO----23
1821--  E  ---60
1822--  a  ---13
1823--YTO----40
1824--CLR----20
1825--CLR----20
1826--CLR----20
1827--XTO----23
1828--  O  ---71
1829--CNT----47
1830--  E  ---60
1831--  YE---24
1832--  E  ---60
1833--  a  ---13
1834--  C  ---61
1835--  I  ---65
1836--YTO----40
1837--  E  ---60
1838--CNT----47
1839--  O  ---71
1840--  π  ---56
1841--XTO----23
1842--  N  ---73
1843--CNT----47
1844--CNT----47
1845--  π  ---56
1846--  a  ---13
1847--  E  ---60
1848--YTO----40
1849--YTO----40
1850--CNT----47
1851--X<Y----52
1852--  C  ---61
1853--  O  ---71
1854--  N  ---73
1855--XTO----23
1856--PSE----57
1857--CLR----20
1858--CLR----20
1859--CLR----20
1860--CLR----20
1861--CLR----20
1862--CLR----20
1863--CLR----20
1864--CLR----20
1865--CLR----20
1866--FMT----42
1867--STP----41
1868--GTO----44
1869--LBL----51
1870--  F  ---16
1871--END----46
```

OPERATING HINTS

TE is defined as the thickness of an attached reinforcing pad or height of the largest 60-deg right triangle supported by the vessel and nozzle outside diameter projected surfaces and lying completely within the area of integral reinforcement (see Fig UG-40 ref. 1). When calculating A2 (area of the nozzle wall available) for integral reinforcement, TE is defined by a configuration such as UG-40 (d) (ref. 1). In calculating A5 (metal in pad(s) available for reinforcement), TE is defined as the average height of the reinforcing pad (see example 4 p. 395 ref. 1). Since the program uses the same value of TE to calculate both A2 and A5, it is recommended that the smaller value be used for TE. This will result in a slightly conservative answer for A2 (See Example 3).

If the reinforcing pad is smaller than the reinforcement limits, the total weld area (even though some may be outside the limit) will be considered for reinforcement by the program.

This program was written to utilize the Hewlett-Packard 9865A Tape Cassette in conjunction with the 9810A Electronic Calculator. For users not having a tape cassette, the program may be run using magnetic cards by performing the following operations:

a. Place program from Tape 1 - File 0 (see p. 25) in calculator.

b. Go to step 1600 of Tape 1-File 0 (shown on page 34) and rewrite the program as shown on the card tape (page 46).

c. With program in the calculator, start at step 0020 and record on a 10-1/2 inch magnetic card and label the card "#1".

d. Place program from Tape 1 - File 1 (see pages 34-44) in calculator.

e. Start at step 0020 and record on a 10-1/2 inch magnetic card and label card "#2".

These two cards are now sufficient to run the program. To run, load card "#1" in calculator starting at step 0000 and press END, CONT. Program will run as with tape considering no reinforcing pads. If reinforcement is not sufficient, program will stop and print the following message: LOAD CARD "#2". User must press LOAD and insert card "#2" into calculator to consider reinforcement pads. After loading card "#2" press END, CONT. and proceed. An option is still provided to optimize the reinforcement supplied.

TAPE TO CARD CONVERSION

```
1575--X>Y---53
1576--GTO---44
1577--LBL---51
1578-- E ---60
1579--CNT---47
1580--FMT---42
1581--FMT---42
1582--CLR---20
1583--CLR---20
1584-- L ---72
1585-- 0 ---71
1586-- A ---62
1587-- D ---63
1588--CNT---47
1589-- C ---61
1590-- A ---62
1591-- a ---13
1592-- D ---63
1593--CNT---47
1594-- 2 ---02
1595--CLR---20
1596--FMT---42
1597--GTO---44
1598-- 1 ---01
1599-- 6 ---06
1600-- 3 ---03
1601-- 8 ---10
1602--CNT---47
1603--LBL---51
1604-- E ---60
1605--FMT---42
1606--FMT---42
1607--PNT---45
1608--PNT---45
1609--PNT---45
1610--YTO---40
1611--1/X---17
1612-- F ---16
1613-- F ---16
1614-- I ---65
1615-- C ---61
1616-- I ---65
1617-- E ---60
1618-- N ---73
1619--XTO---23
1620--PNT---45
1621--PNT---45
1622--PNT---45
1623--PNT---45
1624--PNT---45
1625-- a ---13
1626-- E ---60
1627-- I ---65
1628-- N ---73
1629-- F ---16
1630-- 0 ---71
1631-- a ---13
1632-- C ---61
1633-- I ---65
1634-- N ---73
1635-- G ---15
1636--FMT---42
1637--STP---41
1638--END---46
```

CONCLUDING REMARKS

This computer-aided-design program presents an "interactive" procedure for the engineer, utilizing an electronic desk top calculator, to obtain reinforcement requirements for an opening in a cylindrical pressure vessel subject to internal pressure. The area of reinforcement required for an opening is calculated and compared with the area of reinforcement provided by a proposed design. The program considers as reinforcement: metal in the shell and nozzle not needed to restrain pressure, an inner projection of a nozzle, weld metal, and reinforcing pad(s). The design equations utilized in the program are from reference 1.

The program is written for a Hewlett-Packard Model 9810A Calculator with cassette memory. The necessary program modifications are provided to run the program from magnetic cards.

The program can be modified for a spherical shell under internal pressure by changing the design equations for shell thickness.

REFERENCES

1. American Society of Mechanical Engineers: Boiler and Pressure Vessel Code, Section VIII, Division I, 1974 Edition.

2. Hewlett-Packard 9810A "Programming," "Printer Alpha ROM," "Mathematics Block," and "Cassette Memory" Calculator Operating Manuals, 1972.